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FOR THE

PROMOTION OF THE MECHANIC ARTS.

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EDITORIAL.

In the January number of this *Journal* for the present year, the Editor and Committee on Publications, announced to their readers certain alterations which they proposed to make, and asked for that co-operation by which such changes could most fully effect their primary object, namely, the extension of our circulation, and therefore of the general diffusion of useful knowledge and the excitement of interest in those scientific and practical studies which it is our special object to foster, and which so eminently tend to aid the growth and improvement of an energetic nation.

It seems appropriate, therefore, that in this our final number for the year, we should say a few words as to the success which has attended our efforts, aided as they have been by able and effective co-operation from many sources.

With reference to the course laid out and consistently followed as regards the subject-matter of this *Journal*, we may say, that experience has in all respects corroborated our opinion that practical infor-

mation rather than theoretical discussion, recorded results and the details of their achievement, rather than mathematical processes and methods, however refined and ingenious, are the things best approved and most needed by our practical machinists and engineers. Many opinions have reached us, directly and by circuitous routes, and among much diversity upon other subjects, there seems to be but one sentiment among our readers on this point, and even among those whom unusual mathematical attainments and natural talent, lead to take special interest in abstruse discussions, we have met with such a cordial recognition of the necessities of the case, and such an effectual aid in our plans for building up the influence and effectiveness of the *Journal*, as have been at once gratifying, encouraging and useful.

As regards the financial question, which must exert an important—in, fact a controlling influence upon such an undertaking as the present,—we are glad to state, that, from the increase in our circulation which has been secured, it is probable that in place of the large deficit of the previous year, which threatened the speedy extinction of this publication, a sufficiency of receipts to cover, or nearly to cover expenses, will appear. This gratifying result should in no way relax our efforts, as very much remains to be accomplished which it is in every way desirable to secure.

Thus, better means at our disposal would render possible an increase in the number and excellence of illustrations; would enable us to offer better inducements to those able to supply us with the most valuable contributions, and would give us the means of securing early and reliable accounts of the various engineering works throughout our country, which would be of the greatest value and interest to all practical engineers, as well as men of science and liberal education generally.

In this connection, we may well make an appeal to all those engaged on important works, that, for their own sakes as well as ours, for their own credit as well as for the reputation of their country, they should furnish us, or aid in furnishing, accounts of the character and progress of the structures on which they are engaged.

The ephemeral notices of the daily papers are now almost the only records of the vast works of engineering skill which are scattered over our land, and are daily multiplying; and thus, with unparalleled richness of possession in this respect, America has perhaps the least general credit for the same of any great nation.

This want, it is part of our hope and ambition, in some sort to sup-

ply, if we can but secure the aid of those who are alone able to afford the requisite assistance.

Among the pressing cares and vivid interests of the work, and in the actual presence of the growing structure, one is apt to underrate the value and importance of some literary record, which, however inadequate as an exhibition of the true beauty, grandeur, or efficiency of what it describes, will yet, by its ability of universal diffusion, do far more for the general reputation and perpetual fame of the constructor, than the most sublime actual monument of his skill, and will at distant time and in far-off places, prove a grateful memento and witness of successful labor.

With the New Year and a fresh volume, we expect to employ new type, by which the general appearance of our *Journal* will be improved, and every effort will be made to keep pace with this exterior development, in the increased interest and value of the subject-matter.

This change of type, by reason of certain collateral consequences which it would occupy too much space here to explain, has obliged us, in the present number, to exclude much interesting matter; such, for instance, as the continuation of Professor Mayer's article and Professor Himes' translation of Bunsen's paper, which will, however, appear in our January number without fail.

Asking, then, the indulgence of our readers and contributors for all short-comings of the last year, and with a good prospect and sanguine hopes for the next, we close with our best wishes and the hope of a like return.

ITEMS AND NOVELTIES.

Gilbert's Fire-proof Ceilings.—At the last meeting of the Institute, this invention was exhibited. Its character and arrangement

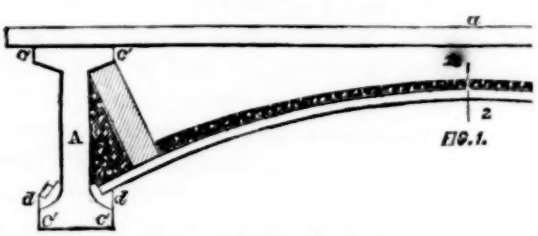


FIG. 1.

will be easily understood from the accompanying drawing, with a few words of description.

A represents one of a series of the usual H-iron girders, on which rests the floor, and between which, spring arched plates of corrugated iron, resting on the sockets *d*, attached to the lower flanges of the girders. These sockets are made to correspond with the corrugations of the arched plates, so as to give them effective support.

The hollows of the corrugations, and as much space above as desirable, are then filled up with concrete, by which additional rigidity is given to the arch, and security against injury from the burning of the floor above. Bricks or blocks placed obliquely against the girders, as shown at c′, fill a like office.

The ease with which the various parts may be handled and attached, the lightness of the entire structure as compared with masonry for a similar purpose, and the consequent economy of the entire structure, form important claims to interest and attention.

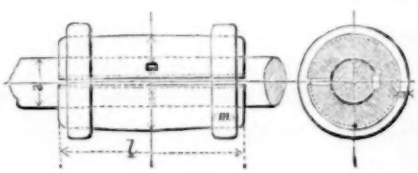
Street Bridges for Foot-passengers.—We learn that the authorities of Paris have accepted a tender for the construction of an experimental iron bridge for foot-passengers for the junction of four streets. This experiment is not new, as is well known. The bridge over Broadway, in New York, has been completed for some time, but is not in very general use on account of the labor and time expended in ascending and descending. Visitors may, however, obtain a magnificent view of the street from this elevation.

Wickersham's Nail Machine.—This machine, of which there was an example in the American section of the Paris Exhibition, produces a headed nail pointed like a chisel and gradually tapered for its whole length. The usual plan has hitherto been to make the plate from which the nails are cut, wide enough for the length of the nail, and then commence cutting from one end and continuing the operation until it is all cut into nails, the machine cutting only one at a time. In the Wickersham machine, a sheet of metal of from 20 to 25 inches is placed, and a series of nails cut from its edges at each stroke of the knives. To do this there are two series of cutters, viz: bed and moving cutters so arranged that by shifting the nail-sheet laterally the distance equal to the length of two nails, each time a series of nails is cut, the nails being alternately reversed as to heads and points. The motions of the machine are only three, viz: the crank motion of the cutter-jaw, the cam motion for shifting the nail-plate, and the feed motion which moves the nail-sheet towards the cutters each time it is shifted and a series of nails cut. In cutting half-inch patent brads or shoe-nails from a 20-inch plate, forty nails

are cut at each stroke of the knives, or 160 per second, the machine driving the knives four times per second. Of patent brads from $\frac{3}{8}$ to 2 inches long, and shoe-nails of all sizes, one machine will cut 3600 lbs. per day. Of the large size nails, one machine will cut 5000 lbs., and ship-spikes $\frac{1}{4}$ to $\frac{3}{4}$ lbs. each, one machine will cut 25,000 lbs. per day of ten hours. This form of nail is said to be more easily driven, and to have a firmer hold on the wood than nails of the ordinary form.—*Practical Mechanics' Journal.*

Shaft coupling invented by John H. Cooper, of the People's Works, Philadelphia.

The coupling here shown, consists of a cylindrical sleeve bored through and through for receiving the shafts, and is turned on the outside, slightly smaller at the ends, tapering conically to the middle; one side is cut through longitudinally to the bore, and opposite this the key-way is formed parallel thereto and from end to end. Wrought iron rings are fitted to the ends.



When the shafts and keys are in place, the bands may be driven on the coupling with such force as will close the coupling firmly on the shafts and unite all as one solid mass.

A good and simple proportion of parts is found to be—

$$D = 2d$$
$$l = 4d$$
$$m = \frac{d}{2}$$
$$n = \frac{d}{4}$$

As all the work on this coupling can be done in the lathe, except the slot and key-way, which may be cut by one long parting-tool and at one setting, it is believed it can be made at less cost than any other form.

When polished all over, it presents a neat appearance, having no projecting parts liable to injure persons or belts.

A number of these couplings have been made and tried in the ordinary practice of shafting and gearing, and have been easy of manufacture and adjustment, and especially easy of removal when it is necessary to take shafts down for change of pulleys and the like.

Tests of Bessemer steel from Pennsylvania Steel Company, Harrisburg, Pa.

We have just received a copy of the following letter, which will be of interest to many of our readers who are consumers of such products:

OFFICE OF A. WHITNEY & SONS' CAR-WHEEL WORKS,
Callowhill and Sixteenth Sts.

PHILADELPHIA, *October* 3, 1867.

Messrs. A. & P. ROBERTS & Co.,
414 Walnut Street, Philadelphia.

GENTLEMEN: The bars of (hammered and rolled) Bessemer steel accompanying your note of 30th ultimo, showed tensile strength as follows:

No. 1 broke at 129,376 pounds per square inch.
" 2 " 120,648 " " "

Both tests stretched during the pulling, the latter especially, its diameter being reduced from 0·498 "to 0·425."

Yours truly,

A. WHITNEY & SONS,
Per JOHN H. REDFIELD.

Trial Record, No. 628.

Engineers' Tools.—In the number of *Engineering* for October 15th, we find an excellent article entitled "Tools and Tool-holders," from which we will give a brief abstract, and for further detail refer to the publication in question.

The expense of making and keeping in order cutting tools, forms a considerable item in the cost of working any engineering establishment, and this being the case it is important that such tools should be constructed in the most efficient and economical form. The ordinary diamond-pointed tool, formed of a bar of square steel, is open to several objections. It is expensive to forge, especially if made in the hooked shape, and its grinding to a correct form requires the expenditure of considerable time and attention. The tool also requires frequent packing up as the surface of the cutting portion is ground away, in order to bring the cutting part in a line with the lathe centres. The position of the slide-rest must also be changed to make it cut cylindrical and flat surfaces.

Rounded steel cutters, held by slide-rests specially formed for this purpose, have been used to obviate this difficulty. For turning small

rollers for cutting mills, &c., this answers very well, since the rollers, from their small size, come nearly up to the level of the lathe centres, and the cutters thus project but little above the top of the rest. In the case of heavy work, however, the projection of the tool would be so great as to cause it to spring and to be unsteady. To get over this difficulty and to render available the advantages which round cutters undoubtedly possess for heavy work, Mr. W. F. Smith, of Manchester, England, has designed a number of tools and tool-holders which we are about to describe. According to that gentleman's plan, the cutting-tool, which is distinct from the holder, is formed of a short piece of solid round steel, ground to the proper angle, and fitted at the proper inclination in the tool-holder, while the tool-holder is of such a shape as will be applicable to all the principal descriptions of work. Six different sizes are made to suit various sizes and classes of work, and for machines varying from large to small sizes, the angle that has been found to give the best results is one in eight measured from the surface planed by the tool.

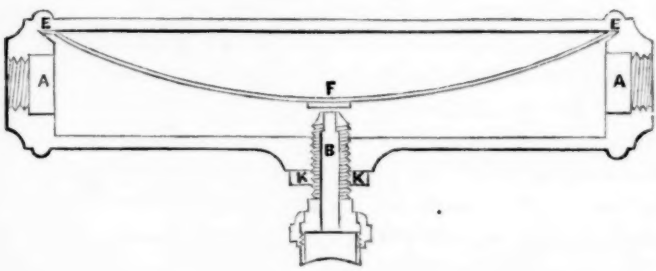
In turning cylindrical surfaces with the round cutting tools, it is, of course, requisite that the cutting point of the tool should be exactly on a level with the lathe centres, and for this purpose a simple sheet iron gauge is supported to each lathe. The maximum depth of cut which any of the round cutters will take is one-half its diameter. Where cuts are to be made of more than $\frac{5}{8}$ inch depth, a cutter is employed made of an oval section of steel $1\frac{1}{4}$ inch deep by $\frac{5}{8}$ inch thick. This oval cutter is capable of making a cut of 1 inch vertical depth in planing a horizontal surface. And, in order that the cutter may not be forced back in the holder by the severe pressure of so deep a cut, the holder is made in this case with a solid bottom behind the tool. As the cutter becomes worn down, a few blanks from a punching machine are placed under its end to fill up the bottom of the socket in the holder.

The quality of the work made with a round steel cutter is found to be much superior to that obtained with the diamond pointed tools, since the smoothness of the finished surface increases in proportion as the thickness of the shaving diminishes. The diamond pointed tool, in taking a heavy cut, leaves the surface as rough at the bottom of the cut as at the top, the shaving in this case being removed of an uniform thickness through its entire depth, while, with the round cutter, the shaving is only thick at the top, gradually tapering away to almost nothing at the bottom, where the shaving becomes merely a tangent to the circular cutting edge of the tool.

At a meeting of the mechanical engineers where these tools were discussed, a trial was made in respect to their relative merits as compared with the diamond pointed tool of the most approved form. The results showed that the round cutters not only made a much smoother cut and a fairer finish, but also required only about three-fourths the power to drive it. A cut was started with the diamond pointed tool with a depth of $\frac{3}{16}$ths in. With a feed of 24 per inch, it was found that a weight of 74 pounds was required, pulling direct upon the driving strap to enable the tool to take the cut. After planing the width of $\frac{5}{8}$ inch, the round cutter, $\frac{5}{8}$ inch diameter, was substituted, going on from where the other left off, and working under precisely the same circumstances, the weight required upon the strap was only 56 pounds.

With regard to the saving effected in current expenses by the use of the improved tool-holders and round cutters, it was found that one smith and striker, who had been almost wholly employed in repairing and making the ordinary solid forged tools, are now dispensed with, and instead of two grindstones being always fully occupied in grinding the tools, the whole grinding of the cutters is now done by a single stone, requiring only one man to attend to it.

A new Steam-trap.—The object of this apparatus is to remove automatically from any steam apparatus air or condensed water. The arrangement now to be described is patented and manufactured by H. W. Bartol, Esq., 1012 Passyunk Road, Philadelphia.



It is arranged as follows: Steam is admitted at A and A. B is a nozzle for discharge of air and water, and also serves as a valve-seat for the valve F, which is carried by a brass spring sprung into the notches E E.

As long as air and water only enter the pipe, A A, the outlet, B,

is open; but when steam enters it expands the spring and so closes the valve. The nipple, B, may be adjusted as required by means of the screw-thread on its outer surface and the jam-nut, K.

The American Tube Well in England.—A trial was made in the presence of a number of gentlemen, near Manchester, a short time since, of the above apparatus. In a field in which the tube was sunk, water was reached in five minutes from the commencement of operations. The well consists essentially of an iron pipe one and a half inches in diameter, about twelve feet long, pointed at one end, and perforated with holes about sixteen inches above the extremity. A movable iron clamp is fitted round the pipe, and, upon the principle of pile driving, a fifty-six pound hollow weight is allowed to drop upon the clamp, thus driving the pipe into the ground. The earth and sand enters through the perforated holes and is drawn out.

This well, it is stated in the *London Artisan*, is free from the liability common to others of receiving surface drainage, the water obtained from it being always fresh and pure.

We can easily conceive that the well must be open to some objections, but its cheapness of construction (except where rock appears, which must be bored) and its rapidity of construction are both great recommendations. The inventor accompanied our army during the war, procuring for the soldiers an unfailing supply of water. He has sunk many wells in this country, and one at Ithaca, N. Y., it is said is 120 feet deep.

The Pacific Railway, intended to connect the railroad system of the United States with California, which is now under construction, will, in connection with the other railway lines already completed, cross the continent in a direct line from New York on the Atlantic to San Francisco on the Pacific Ocean, having a total length of 3300 miles.

A New Cable.—A telegraphic company proposes to lay a cable between the coasts of England and Prussia, which will connect with a continental line traversing Prussia and Russia, and to continue by another cable through the Black Sea. This last cable to join those already existing which traverse Persia, and to continue on the shores of the Persian Gulf to Karrachee and Bombay.—*Les Mondes.*

The Railway between Protzen and Innspruck, over the Brenner Alps, was opened for traffic almost simultaneously with the line over Mont Cenis. It is expected as a consequence, that the trade of

Trieste will be absorbed by Venice, and that Italy will be greatly benefited.

Forging by Pressure.—The applications of this process are daily increasing in number, and in the generality of their employment, especially in England, as we learn from an authority thoroughly conversant with the subject. Thus the hooks and many other parts of differential pulleys are shaped, as also hammers and other similar instruments.

Grinding with a Cast Iron Wheel at high velocity, is a process successfully conducted at the works at Frankfort, near this city, where the process is found to be both economical and efficient.

Hover's Eukollon, or White Liquid Paste. At a late meeting of the Franklin Institute, this article, invented by Joseph Eves Hover, was exhibited among other things of greater moment, but not of more constant use, more daily convenience, or greater individual efficiency, in their special office. The article is a white paste of superior adhesive properties, but, above all, so prepared that it will keep in a warm room for any time without fermenting. It may thus be always at hand, and being so, will be, moreover, always ready and fit for service.

The Horizontal Moon.—We have received from Messrs. Wilson & Hood a stereoscopic diagram, designed by Prof. C. F. Himes, to illustrate the cause of that apparent increase in the area of the moon when she is seen near the horizon. The diagram consists of two figures on one, consisting of a large circle with a smaller one concentrically placed, the other of a large circle exactly like the former, having within it, however, two small ones equal and eccentrically placed at an eighth of an inch right and left of the centre. When viewed in the stereoscope, this gives the impression of a large circle on the surface of the paper, a small one back of the paper, and a yet smaller between the paper and the observer. The actual size of these latter circles must be the same, since they are each formed by the union of the small circle of one figure, with one of the small circles of the other; but since the one seems to be further off than the other, we instinctively assign the greater size to that which seems to be furthest off, and yet subtends an equal angle.

Thus it is with the moon when near the horizon. Comparison with surrounding objects causes us to assign to it a greater distance than when it is near the zenith, and thus in turn to consider that it is larger.

Railways in Russia.—A line from Warsaw to Terespol has just

been inaugurated; it is 193 versts (128 miles) in length. It has been completed two years before the time specified in the concession granted to M. Kronenberg by an imperial "UKASE" dated October 21st, 1864. A number of large locomotives have been shipped from Havre for Russia.

The East Indian Railway.—From statistics published in a late number of *Engineering*, we find that the financial condition of the above railroad is in a most flourishing state. The number of miles first opened to traffic were only thirty-eight, and the profits were 928 rupees per open mile. The number of miles now open is 1129, and the profits have reached 10,857 rupees per mile. The working expenses have heretofore reached, on an average, 50 per cent. of the gross earnings; but for the last few years there has been a slight improvement in this respect. In 1866 the working expenses were reduced to 44·2 per cent. of the gross earnings, showing that the management is now conducted on more economical principles. A rupee is worth about 44 cents.

Petroleum in India.—A Calcutta paper states that petroleum has been discovered in the Bengal presidency, and that 5000 gallons have already been shipped to Calcutta.

The Ceylon Railway was opened for traffic to a limited extent, on 16th of September last. The charges are at present high, creating discontent among the planters. This will, however, doubtless be modified shortly.

The Pacific Railroad.—Ten thousand Chinese coolies are employed in cutting the way over and through the Sierra Nevadas. They are under the direction of American engineers, and are said to be very tractible, and work at a rate 50 per cent. cheaper than white laborers.

How the Union Pacific Railroad is Built.—We have received a prospectus of the Pacific Railway Company, from which we extract the following interesting letter, written by a gentleman who traveled over that portion of the road which was completed in June last:

There is nothing connected with the Union Pacific Railroad that is not wonderful. The possibility of constructing such a road at some future day, has long loomed up as one of the events of a grander future which all believed was to come for the land. To look upon so much of it accomplished, to watch the marvelous progress of each day, and feel sure that the great enterprise which we had consigned to the

future of our dreams, is to be a reality for us, makes one prouder of the noble days in which we live. In one sense the road is as great an achievement as the war, and as grand a triumph; to those who have seen much of the former and looked from this point upon the unfoldings of the latter, they appear equally impressive. What the country has been dreaming about for many years is becoming a reality much faster than the people know. One year ago but forty miles were finished; this morning, we look back from our train over a days rapid run, and forward sixty miles. To-night, three additional miles of rail will mark the track of the day's advance.

Our party left the depot at Omaha at 9 o'clock on the morning of the 3d inst. The station-house, and the common passenger cars, were better than those on the road from Washington to New York; those who have been so unfortunate as to make the latter trip will all hope they are *very much* better, if the love of country be in their hearts.

The train, which was made up for the excursionists, consisted of cars as elegant as any that can be found east of the Missouri. It was very difficult to look at them and realize that before night they would be roaring along over plains from which hostile Indians, deer and antelope have not yet been driven.

Long before the valley is reached it spreads before the eye like a vast bay opening out into an ocean, whither the track appears to lead. It is forty miles from the low, rolling hills on the north, to the opposite and similar range on the south. Between, the surface is almost perfectly flat, though its regular ascent toward the west, of about ten feet to the mile, gives ample drainage. The soil is very rich, and the mind falters in its attempt to estimate the future of such a valley, or its immense capabilities. The grain fields of Europe are mere garden patches beside the green oceans which roll from Colorado to Indiana. The valley widens with the advance. The hills behind sink into the plain until the horizon there is perfect. Those on either side grow fainter, till through the heated air they take on the appearance of low islands seen across many miles of water.

Much of the land at the mouth of the valley is under cultivation, and the deep black of the freshly turned loam, the dark green of the wheat, the lighter grass, the deeper shades, and the brown of that which the fires of the autumn spared, make of the wide expanse a mosaic which nature alone could color, and the prairies only find room to display. Further on, huge plows, drawn by eight oxen, labored slowly along, each furrow being an added ripple to the tide which is

sweeping up over all these rich regions—a tide whose ebb the youngest will never know.

The common mile-posts seem to measure insignificant distances upon the wide plains. Only each five miles are noted on this road, and when one has passed between two of these, the step taken hardly appears like an advance. But there is one point marked in a manner to suggest the distance which has been overcome, and the gigantic character of the work. At a point in the plain which otherwise seems as indeterminate as the position of a floating log at sea, a wide, arched sign between two strong set posts, bears this inscription: "100th meridian—247 miles from Omaha." Here was the terminus of the road only last September.

Crossing the North Platte, on a bridge about three thousand feet long, the train soon stopped at North Platte Station. Last fall there was no building here. Now the railroad company have fine brick car houses, there is a good hotel, where excellent fare is provided, and on the main street fronting the track are thirty-six buildings. The depot and warehouses are overflowing with stores of all kinds.

Within twenty miles of the end of the track, a few of the party rode on the cow-catcher. It seemed marvelous to drive on at twenty miles an hour over rails that had only been down for ten days. But the perfection with which the work is done allows it, and makes it safe.

Three hundred and twenty-five miles out, a construction train of eighty cars stood on a side track. It was loaded with iron, ties, spikes and chairs, in exactly such proportions as were needed. It looked the very embodiment of system, and was one key to the rapidity with which the work progresses. A little further on stood a similar train, and next we stopped in rear of the one where the tracklayers resided.

The road had been a constant wonder from the start. Its depots, its car-shops, its equipment, its remarkable smoothness, its high rate of speed, its long bridges, and its well ordered eating-houses, had attracted constant attention to it as a railroad alone.

Every step trod revealed new wonders. The great achievement grew upward toward its real proportions with every throb of the engine. But all we saw was commonplace and natural beside the scene that awaited us where the track was being laid. If the rest had excited amazement, this new wonder took all the attributes of magic. Fictions of the East must be re-written to match the realities of this West.

The plain fact will reveal the magnitude of the work. There is

really little known by the people of the character of the enterprise. Most think that a company of capitalists are hastily putting down a rude track, over which cars can be moved with care, for the purpose of securing lands and money from the Government. The fact is, that one of the most complete roads of which the country can boast, with equipments that surpass many, is being laid with a speed that fails to impress the nation simply because it is not believed. But let the facts tell their plain yet wonderful story.

Generals J. S. and D. C. Casement, of Ohio, grade the road, lay the track and put up the telegraph. The graders go first. There are 2000 of them. Their advance is near the Beach Hills, and their work is done to Julesburgh.

Of tie-getters and wood-choppers there are 1500. Their axes are resounding in the Black Hills, over Laramie Plains, and in the passes of the Rocky Mountains. They have 100,000 ties in these hills awaiting safeguards for trains to haul them. Then follow the tie-layers, carefully performing their share of the work.

Now go back twenty miles on the road, and look at the immense construction trains, loaded with ties and rails, and all things needed for the work. It is like the grand reserve of an army. Six miles back are other trains of like character. These are the second line. Next, near the terminus, and following it hour by hour, are the boarding cars and a construction train, which answer to the actual battle-line. The one is the camp; the other is the ammunition used in the fight. The boarding-cars are each eighty feet long. Some are fitted with berths; two are dining halls; one is a kitchen, store-room and office.

The boarding-cars go in advance. They are pushed to the extremity of the track; a construction train then runs up, unloads its material and starts back to bring more from the second line. The boarding-train is then run back till it has cleared the unloaded material.

The trucks, each drawn by two horses, ply between the track-layers and their supplies. One of these trucks takes on a load of rails, about forty, with the proper proportion of spikes and chairs, making a load, when the horses are started off on a full gallop for the track-layers. On each side of these trucks are rollers to facilitate running off the iron.

The rails within reach, parties of five men stand on either side. One in the rear throws a rail upon the rollers, three in advance seize it, and run out with it to the proper distance. The chairs have,

meantime, been set under the last rails placed. The two men in the rear, with a single swing, force the end of the rail into the chair, and the chief of the squad calls out "Down," in a tone that equals the "Forward" to an army. Every thirty seconds there came that brave "Down," "Down," on either side the track. They were the pendulum beats of a mighty era; they marked the time of the march and its regulation beat.

If it is asked, "How does the work get on?" again let the facts answer. On the 9th of May, 1866, but forty miles of road were completed. In a hundred and eighty-two working-days thereafter, two hundred and forty-five additional miles were laid and put in prime condition, every rail and tie and spike having been brought up from the rear. Seven saw-mills furnish the ties and lumber. All bridges are framed, the pieces numbered and set up where wanted, without the least delay. The bridge at Loup Fork is 1500 feet long, and as fine a Howe truss as can be found in the land. While our train was running the sixty miles from North Platte, over a mile of track had been put down, and our train passed over it. From one o'clock till four in the afternoon, a mile and two hundred feet were added to this while the party was looking on.

After the return of the party to Omaha, it visited the extensive shops of the railroad company at that point.

The depot grounds, upon which they are situated, contain forty acres, specially devoted to these buildings and to passenger and freight traffic. Within five years it is estimated that the whole of this space will be needed for the business of the road.

The engine-house will hold twenty-one locomotives. There are two others further west. Thirty-two engines are already in use on this road, whose terminus is in the "desert," and twenty-three more are on the way and already wanted. Those last constructed are coal-burners. The fuel to move them is to come from the Black Hills. In a few years it is confidently expected that the iron to supply these very works will be obtained from the same point. Think of importing iron for Omaha from the West!

Passenger cars are in process of construction equal to the best. Emigrant cars were being built, and the frames of an hundred freight cars were ready to be put together. Several traveling post-office cars are already finished. For stations on the route, the distributing boxes will be marked "North Platte," "Fort Laramie," "Salt Lake," "Sacramento" and "San Francisco;" while the closed pouches at no

distant day will be labeled "China, Through," "India, Official," "Sandwich Islands," "Russian America" and "Japan." And the cars are built as if the service were already secure. Every particle of work, in all the multifarious kinds demanded, shows implicit faith in a future of grand proportions for the road.

The preliminary organization of the Union Pacific Railroad Company was made in October, 1863. The first contract for construction was made in August, 1864; but various conflicting interests connected with the location of the line, delayed its progress, and the first forty miles were not laid until January, 1866. At that time all obstacles were removed, and the road has been built more rapidly than any other similar work in the world. There were 305 miles completed on the 1st of January, 1867, and now 500 miles are in running order, and forty-seven miles more track will be laid the present season, if the weather permits. Contracts have been made for rock-cuttings beyond, to be done during the winter, and the grading has already commenced west of the Black Hills in the Laramie Plains. The work on the California end of the route is being pushed forward with great energy towards the east, and it is expected that the whole grand line to the Pacific will be open for business in 1870. The present outfit of the company comprises ample depots, stations, car and repair shops, and all the equipments of a first-class road. It has now in use fifty-three locomotives, twenty passenger and mail cars, and seven hundred and ninety-three freight cars.

Coal Mines of Russia.—Editors of the English Mechanical Magazines are now calling the attention of their countrymen to the vast coal mines of Russia, as a source from which the supply of coal may be furnished, should the mines in England become exhausted as geologists fear. The chief difficulty at present in working the mines is the want of railway communication. This difficulty, however, appears likely soon to be obviated, as railway lines are fast spreading in all directions.

The Elevated Railway in New York City.—The experimental mile of this structure, which has been in course of erection on Greenwich Street, is now nearly finished, and will be in operation within a few days.

The tracks are supported on a single row of wrought iron columns by means of cross-heads, and the cars will be run by an endless band operated by steam-power, at fixed stations, and carrying projections at distances of fifty feet, which by simple means may be made to engage the cars, or be disengaged from them.

Civil and Mechanical Engineering.

(Concluded from page 316.)

THE NEW YORK CENTRAL PARK.

By WILLIAM H. GRANT, Superintending Engineer.

Gutters.

SEVERAL kinds of gutter have been tried for the Park roads. The first kind was the usual form adopted for city streets,—that of flat stones for the bottom of the gutter with a strong curb-stone set at the side, with a slight inclination outward, [Plate I., Fig. 1, facing page 238 of vol. liii.]

This form was adopted for the first sample of road that was constructed.

The stones were of Hudson River "blue-stone," such as are generally used in the city of New York for gutters and for the flagging of sidewalks.

The bottom stones of the gutter were about 16 inches wide and 4 inches thick, and in pieces from 4 to 6 feet long. The curbs were 20 inches deep, 5 inches thick and of similar lengths to the bottom stones, the upper edge being cut to a bevel, so that when the stones were set, inclining slightly outward from the road, the top surface of the curb-stone conformed to a horizontal line transversely of the road.

The curb-stones were set first, and were filled around with coarse gravel or broken stones. The bottom stones were then laid on a well-rammed bed of the same material, the upper surface of the stones having an inclination or pitch toward the curb of about 2 inches in the breadth of 15 or 16 inches. Broken stones or coarse gravel was then well rammed along the inner edge of the stones, to hold them firmly in their places, and the road material was subsequently joined up to them flush with their upper surface.

The curb-stones had a height of 6 to 8 inches above the gutter-stones, and the rear was filled in with earth, and a sward was formed even with, or rounded a little above, the tops of the stones.

This kind of gutter was the first to be brought into use, and has stood very well during a service of about seven years; it has been but little disturbed by frost, and shows no material effects of wear. A little unevenness of the curb-stones has been caused by the action of frost, showing that a greater depth of the stones would be desirable.

The pitch of the gutter-stones was made to correspond with, and form a continuation of, the sloping surface of the roadway, so that carriage wheels pass freely and easily from the roadway into the gutter and close along the curb, without the inconvenience usually attending the driving into gutters composed of cobble or quarry stones.

The curb forms a very desirable barrier against the encroachment of carriage wheels upon the grass borders by careless driving, or by any ordinary chance during a crowded state of the road, and it also gives a well-marked outline to the road. The ease of driving into and occupying the gutters as a part of the road, as occasion requires, gives to this form of gutter a practical advantage, as compared with the ordinary paved gutter, that is equivalent to an increased width of the road of two or three feet. This is a feature that should not be lost sight of in estimating the cost of the gutter, as compared with the cost of other kinds, as it may be regarded in the light of a saving of the expense of a portion of the width of the roadway equal to about the width of one gutter.

The next kind of gutter that was tried was similar in form to the first, having an elevated curb; but it was composed of stones that were obtained chiefly on the Park, and at less expense, [Plate I., Fig. 2.] The curbs were formed of stones selected from the rock excavations, and roughly dressed to give them a tolerable uniformity of shape, and to fit them evenly together when set. They were mostly long-shaped stones and were set about 2 feet deep in the ground, and filled around, in the same manner as the blue-stone curbs, with gravel or broken stones to guard them against frost.

The gutter-stones were of cobble or field-stones. These were set so as to give a concave form to the upper surface, with a depression in the middle of 2 to 3 inches, the width of the gutter being 2 feet. The stones were generally from 4 to 6 inches in breadth, and of an equal or greater depth, deeper ones being selected to form the inner edge of the gutter next to the roadway, and only such were used as were hard and sound. All were set compactly together, on a filling of gravel, quarry chips or broken stones and were well rammed, and the interstices afterwards filled with gravel or coarse clean sand.

The gutter formed in this way was similar but superior to an ordinary cobble-stone pavement, as pains were taken in the selection of the stones, and in placing their best or flattest surfaces uppermost.

The work has proved very durable and has a firm substantial look, and remains apparently undisturbed by use and as true as when first

put down. The roughness of the stones, when driving over them, is not felt to the same extent as in the case of gutters composed of quarry stones. The curbstones, though roughly shaped and fitted, are strong and serviceable, and, except their roughness as a fender against carriage wheels, answer the purpose as well as the more expensive blue-stone curbs.

In some positions, where a high finish is required, the rustic outline they give to a road (which is in strong contrast with that of the dressed blue-stone curbs) would not be desirable; but ordinarily this is a feature that is quite in harmony with the surroundings of rural roads.

After observing these gutters during the period that they have been in use, and comparing them with other forms subsequently constructed, the original conclusion in regard to them is very much strengthened, that they are well adapted to park roads.

A strong well-defined curb, rising a suitable height above the bed of the gutter, not only marks with necessary clearness the boundaries of a road and defines its curves and sinuosities, but is a reasonable safeguard against negligent driving, on a road that is liable to be crowded, and is a protection to grass borders and shrubbery, as well as to pedestrians, where the walks and roads run, as on a considerable portion of the Central Park, parallel and in close proximity with each other.

The curb is also of advantage in giving ample capacity to the gutter for discharging water in an emergency, and preventing it from breaking over the borders of the road.

The "blue-stone" gutter, with accurately dressed curb, and squared, close joints, is expensive, and is more appropriate for a road where, from position and special adaptation, a highly finished and formal outline, or a barrier of more than ordinary security, are required, than for a road for general park purposes occupying a great variety of ground.

The gutter with rustic curb is not open to the objection of expense, as it is one of the cheapest kinds that has been constructed; it has also proved, after several years service, to be at least equally durable with other kinds. A slight addition to the first cost of this gutter would give to the curb-stones more evenness of surface and closer joints, which would be desirable to perfect them as fenders to carriage wheels; it would also add to their stability and prevent the intrusion of grass in the joints. With care in selecting the stones, broader and more regular shaped ones can generally be obtained from stone quarries, than such as were used in making the sample that has been described.

With these improvements, and, if practicable, the addition of a few

inches to the depth of the curb-stones (making them not less than 2½ feet), this kind of gutter would combine all the qualities and features needed for practical purposes, and at a cost not exceeding that of any other kind equally serviceable.

The foregoing gutters, with elevated curbs, together with the one next described, were made in connection with that portion of the Park carriage road lying east of the Mall, and extending northwardly past the Casino, and turning out to the Seventy-second street entrance on Fifth avenue.

The next kind of gutter tried was composed entirely of brick, [Plate I., Fig. 3.] It had the same general form and dimensions (except the curb) as the cobble-stone gutter. Hard, thoroughly burnt, well-shaped bricks were used, the bricks being set on edge lengthwise of the gutter, except those in the exterior courses, which were set on end in the form of ties or headers in a wall. The bricks were laid so as to break joints with each other, and closely together, in the form of an inverted arch corresponding with a prescribed pattern. The outer course of bricks was raised 3 inches above the surface of the gutter, to add to the capacity of the gutter and to serve as a partial curb. This arrangement of the bricks necessitated the pitching of their tops inward, in consequence of the concave form of the gutter, instead of giving them the usual inclination of a curb in the opposite direction. This was not a favorable form to serve as a fender to carriage wheels, but it was a difficulty that was unavoidable in the use of brick. Carriage wheels, in coming in contact with the overhanging corners of the bricks, have a tendency to climb instead of sliding off, as in other cases, by which the bricks are occasionally chipped or broken.

In other respects, this gutter has been successful and wears well, resisting frost and keeping in shape very perfectly. The bricks were bedded on a filling of coarse gravel or quarry chips and rubble, and were afterwards settled by careful ramming. A light coating of sand was then spread over to fill up the joints.

Although this kind of gutter possesses strength and stability sufficient for the purpose intended, yet it has an appearance, in contrast with the other kinds, of weakness and inappropriateness as the defining boundary of a broad and substantial carriage road. A stronger and more decided curb is needed, and a general want of harmony and fitness is felt to prevail between the brickwork and other features and surroundings of the road.

The cost of this gutter was about the same as that of the cobble-stone gutter with rustic curb; it is not probable, however, that it will prove as enduring.

A modification of the cobble-stone gutter was next tried. This consisted merely of the substitution of a dressed blue-stone curb similar to that first described), in place of the rustic or quarry stone curb. This gave a higher finish to the gutter, but at a considerably increased cost. Where a formal outline is desirable, the cost not being an objection, such a gutter would be very suitable. It is less expensive than the gutter composed throughout of blue-stone (as the first sample), and, excepting the difference in the smoothness of surface, it is preferable to it. The curb-stones should not be less than 2½ feet in depth.

A gutter composed of small quarry stones, set on edge, was the last form resorted to, and this has since been generally adopted for the Park roads. It was first tried with a binding of blue-stone (not raised as a curb) along the outside, the upper edges of which were flush with and formed a part of the concave surface of the gutter, [Plate I., Fig. 4.] The object of the blue-stone was mainly to prevent the grass along the borders from encroaching upon the gutter, and to give a more regular and distinct edging to the gutter than could be done with small or undressed quarry stones. It was found, however, that these advantages did not compensate for the extra expense of the blue-stone, and besides, there was a practical difficulty in setting the blue-stone in connection with the quarry stones of irregular sizes, so as to make close and substantial work, and the use of the blue-stone in this form was therefore discontinued, the final form being as shown by Fig. 5.

The quarry stones for these gutters were prepared at the quarries or places on the Park where rock was excavated, in grading the roads or for other purposes. The blocks of stone blasted out were broken up by men who were practiced in the work, and were reduced by rough hammering to the forms and sizes prescribed for the gutters.

The specification for this part of the work requires the stones to be "from 8 to 12 inches deep, and not less than 3 inches thick, the lengths" (longitudinally to the gutters) "being whatever the stones will work to, not less than 6 inches nor generally more than 15 inches; the dressing to be sufficient to square the stones roughly, so that they will fit together compactly in the work, the wedge-shaped form to be avoided, and a fair bearing surface given to the lower ends of the

stones; the tops of the stones, if sharply pointed, also to be knocked off. Only sound and hard stones to be used."

Previously to setting the stones, a bed is formed to receive them of gravel or sand, or fine quarry chips and rubble well rammed.

The gutters vary in width, according to circumstances, the width of the roads, nature of the drainage, &c., from 18 to 36 inches, generally from 24 to 30 inches; the depression in the middle being from 2 to 4 inches, and proportioned to the width.

Stones having the greatest depth (not less than 12 inches) are selected for the exterior edges of the gutter, and all are set with care by practical pavers, so as to conform truly to the grade-line of the road and to the required concave shape. The exterior stones are protected and kept in place by ramming gravel or quarry chips alongside as the work proceeds. The road material is subsequently added on the roadside of the gutter, and on the opposite side the earth border is closed up to it. The gutter is firmly settled into its bed by the use of rammers, and the interstices between the stones are thoroughly filled with clean gravel or fine stone chips.

The cost of this kind of gutter does not vary materially from that of the cobble-stone gutter with rustic curb. The surface is not as smooth or as agreeable to drive over as the sample of cobble-stone gutter that was previously made, and is naturally avoided by carriages (as it is desirable that all gutters should be), except when the road is overcrowded.

The absence of a raised curb, and the tendency of the grass along the low border to run into the inequalities of the stones at the edge of the gutter, give the general effect to the road of blending with the adjoining sward without a very decided line of demarkation.

This would not be an inappropriate feature for roads in some situations, where they are not liable to be overcrowded; but for Park roads, for the reasons before stated, the stronger outline of a substantial curb (similar to the two forms first recommended, Figs. 1 and 2) is considered preferable.

The quarry stone gutter is substantial and durable, and improves in smoothness with use. Where suitable cobble or field-stones cannot conveniently be had, and in cases where such stones would contrast too strongly in color with the road material to be agreeable, the quarry stones would be recommended.

The question of cost, however, under ordinary circumstances, would be regarded as sufficient to govern the selection of those different kinds of stone.

THE WASHINGTON STREET TUNNEL.

HISTORY AND PROGRESS OF THE WORK FROM ITS COMMENCEMENT TO THE PRESENT TIME.

On the 31st day of August, 1866, a contract was made by the board of public works of this city with Stewart, Ludlam & Co., to construct and complete a tunnel under the Chicago River, at Washington Street, to the satisfaction of the board of public works of said city, the work to be done in accordance with plans prepared for the doing of the same on file in the office of the board, and with the specifications appended thereto (both plans and specifications being subject, however, to such changes as said board might direct), with the stipulation that the work was to be finished and fully completed on or before the 31st of March, 1868, the time of completion being an essential condition of the contract. On the 2d of October, 1866, the works were formally commenced on the west side of the river, between Canal and Clinton Streets. On the 6th of December the first pile for the coffer-dam was driven into the bed of the river. Some time in the morning of the 23d of December, the braces that had been put into the excavation, to protect the clay from falling, gave way, and the banks caved in, carrying the truss, steam-engine and engine-house partly along with it.

On the 17th of May the contractors suspended operations on their works, and on the 14th of June, 1867, the sides of the excavation on the east side of the river, and all bracing supporting it, caved in, and has remained much in the same state at that point to the present time.

On the 20th of July the present contractors, Messrs. Lake, Clark & Farwell, entered into a contract with the board of public works to construct and complete the tunnel, said work to be done in accordance with plans and specifications prepared for the same, on file in the office of the board. On the 25th of July the contractors commenced operations on East Washington Street, between Franklin and Market Streets, and from that time have been operating extensively on the works.

The length of the work is about 1605 feet from the centre of Franklin Street to the centre of Clinton Street. The length of the retaining walls of the open approach on the west side is about 320 feet; those on the east side about 273 feet. The length of the main archway or covered way is about 932 feet.

The tunnel will be provided with ample drainage, ventilation and gas-lights, and it is supposed that it will be perfectly dry. The abutments are provided with weeping drains at every 20 feet, so that any water may freely percolate through the pores of the clay from the surface through these drains and be conveyed through the drainage for that purpose in the inverted arches, and thence be conveyed to the well in the centre of the river; then discharging into a sewer 4 feet in diameter and 120 feet in length, to another well 10 feet deep; from this well a shaft is to be carried up to the surface of West Washington Street, and all water collecting in the well will be pumped out by means of a pump, as may be decided upon by the board of public works.

The contractors, up to the present time, have excavated about 14,000 cubic yards of earth, and have built about 2500 cubic yards of stone masonry in the retaining walls; 400 cubic yards of concrete foundation; 150 cubic yards of stone foundations; 250 cubic yards of stone backing to abutments; 150 cubic yards of brick masonry in walls and arches, together with about 20 cubic yards of cut stone coping quoins, and arch stones, and have been industriously engaged constructing wharves and on a new coffer-dam, for the better prosecution of the works.

The first stone of the east entrance to the tunnel was laid October 19, 1867, by William Bryson, civil engineer, and the arch of cut-stone was keyed October 31, and was pronounced by Mr. Bryson and Mr. C. B. Farwell to be the Doyle arch of the Washington Street tunnel, Thomas Doyle having set the arch-stones to the satisfaction of Mr. Bryson. Mr. George Everitt is inspector of masonry on the east side, and Mr. Kroeschell on the west side, on the part of the board of public work. Mr. P. McMahon Burns is foreman of stone-cutting for east and west sides and of masonry on the east side, and Mr. William Winchester foreman of masonry on the west side, on the part of the contractors, together with Mr Bernard McDevitt as foreman of carpentry, attending to the necessary bracing and shoring of the excavation, &c. Mr. Harper is superintending the work of the coffer-dam.

Mr. William Bryson is the engineer in charge of the construction under the immediate control of E. S. Chesbrough, Esq., the city engineer and chief engineer to the board of public works.—*Chicago Times.*

MEMORIAL

OF

BREVET BRIGADIER-GENERAL B. S. ROBERTS,

ON A PLAN FOR

Reclaiming the Waste Lands of the Lower Mississippi.

WASHINGTON, D. C., *January*, 1866.

SIR: The magnitude of the subject I propose in this memoir to bring to your notice, and through you to the consideration of Congress, and the vast interests involved in reclaiming and converting to the use of the world the delta lands of the lower Mississippi valley, would suggest a sufficient excuse, were any necessary, for this manner of expressing my views on this subject, and attracting the attention of the country to the unappropriated elements of prosperity in the material of the waters of Mississippi, borne on by its eternal flood and constantly wasted in the tides of the Gulf of Mexico.

I here propose briefly to suggest my undoubting conviction that a new plan of diking the lower Mississippi, in connection with a system of waste-wiers and gates, so constructed at proper distances in the levees of the river, that during all the seasons of great floods, vast volumes of the waters of the river, thick with the delta-making material borne down in the Missouri and other great rivers of the northwest, may be turned off to overflow the extensive swamps and morasses and fill the lagoons and lakes abounding between the table-lands and the proper alluvial bottoms of the lower Mississippi basin, depositing in them and creating from these waters new and rich delta lands, and by degrees raising them to the level of the stream when in flood. In this manner it is proposed to redeem them from their present waste, turn them to bottoms exuberant in richness, for the culture of cotton and sugar, relieve the country from their fatal malarias, and create sanitary and productive soil where morass, swamps, stagnant lagoons and lakes are the fruitful causes of the contagions and pestilences of this region.

The fact that an engineer of the army, distinguished for capabilities as a general, and in scientific and practical engineering, has been charged by you with the repairs of the levees, neglected and destroyed since the beginning of the rebellion, and sent to superintend their reconstruction, suggests clearly to my mind your views of the powers

of the government to take in hand any measures of this nature, involving and facilitating commercial intercourse with the many States washed and traversed by the tributaries of this great "inland sea," and all emptying their floods through this great lower basin of the Mississippi into the Gulf of Mexico.

How far the government, under its constitutional powers "to regulate commerce between the different States," can, incidentally, in improving the navigation of this tide-water river, introduce improvements by any new system of diking, releasing the main flood-waters from existing banks and beds, so as to divert their creative material of delta *into* the *swamps*, lagoons and lakes of the States of Arkansas, Mississippi and Louisiana, and reclaim them from wastes, productive only of contagious fevers and pestilences, Congress must decide. But it is my judgment, offered, however, with diffidence, as clearly within the powers of Congress as it is to pass laws of quarantine and health, or laws to protect life and preserve health on steamers that navigate this river or the high seas. Preventive measures against pestilence and epidemics at home are, or ought to be, as much under the control of Congress as legislation to close our harbors and rivers against their importation from abroad.

At all events, the right of the government to improve navigation of rivers that flow into the sea is conceded; and under this concession, I shall proceed to show that the plan I propose goes directly to this point, and is one of the most economical and practical the government can adopt.

Under the present regimen of this river, as partially regulated by existing systems of dikes, the waters, charged with their rich and fertilizing material forming our deltas, are not permitted to spread themselves over the great alluvial bottoms of the States I have mentioned, but are borne on into the Gulf, depositing their material near the great mouths, and constantly forming new land there.

The heavier water of the sea, and the stronger tide and stream of the Gulf, throw back this material, and deposits it in and about the confluence of the fresh with the salt water. Here it creates and increases bars, setting back as dams set back the waters in their channels, and in progress of time raises the water in the main beds above their banks, requiring continually higher and stronger dikes to prevent overflow, and the destruction of plantations whose levels are below high water-lines.

These are the unchangeable laws governing the creation and growth

of great alluvial bayous and bottoms. They are nature's laws, and can only be partially changed by artificial means, in a greater or less degree, however, as the skill and ingenuity of man, practically applied, may alter them.

The geography of the great Mississippi bayou is particularly favorable to the successful application of skillful engineering, so as to control the regimen of this river, and in the progress of time, aiding and directing its flood to accomplish by its own power and perpetual laws. the regeneration of its wastes of marsh, swamps, morass, lagoons and lakes, and make them prolific sources of wealth.

The system should begin up the river where dikes are necessary to preserve the plantations and cultivable lands from overflows by high water. From these points to the mouth of the river waste-weirs of timber, with riveted aprons of plank, should be constructed in the levees, so as to carry off the flood-waters into the swamps, marshes, and lagoons, depositing in them the delta-making material of every flood, while the water by evaporation, spreading out over greater surface, wastes itself, is drank up by the soil, or filters itself through the sands and is lost in other outlets to the Gulf. The proportion and numbers of these waste-weirs must be regulated by the topography of the country, the extent of morass, swamps, lagoons and lakes to be filled. The most thorough surveys by practical and skilled engineers should be made to determine their number and the volume of water they should waste.

The cost of such waste-weirs or aprons, at five hundred or even a thousand points along the length of the levees from Tennessee to the mouth of the river, would be an insignificant figure above the cost of the earth levees as now constructed. They would, in fact, form only another plan of diking, by using at intervals timber instead of earth, built at a less height, riveted with plank aprons, over which the water with its delta-making material will flow into the low swamps and morasses during all seasons of flood.

Compared with the benefits to the country, it would be economy should they cost millions; for in all time they would be creating new and rich lands, and precipitating the time when, in God's unchanging creative laws, to prepare the earth for the growth and development of man under the Divine decree to multiply and replenish the earth, "the mountains shall be made low and the valleys exalted."

Illustrations without number are conclusive of the truth of my theory and its practical application. Few men have lived long in the

lower basin of the Mississippi River without observing its realization in the formation in a few years of new islands and lands whenever heavy floods and the drift they often lodge in the beds of the river, have changed the direction of the current of the stream so as to form eddies. Here the force of the stream ceases to carry on the delta-making material with its current. In a single flood large deposits are precipitated, forming the foundation for a new island, increasing in its proportions with each succeeding flood, and in the lifetime of a single individual growing to the magnitude of a planting habitation. In fact, these changes are so sudden, and the accumulation of delta so extraordinary in a very few years, that pilots of the lower Mississippi, absent or unemployed for such periods of time, are lost in their bearings, and must study the new landmarks to resume with any degree of safety the helm of the steamers that thread the changing channels of this mighty river.

It must be conceded, then, that much of the delta-making material in the waters of the Mississippi that would be borne into the Gulf in its natural flow, can be spread out by artificial means, and deposited in the swamps, marshes, morasses, lagoons, and bottom lakes of its lower basin. This will lessen so much of the formation of new land and bars at the embouchures into the Gulf; and while it lessens the constantly accumulating and elevating alluvium there, that sets back the water in the bed of the stream, increasing the obstruction to navigation by enlarging the bars and necessitating the construction of higher dikes to save the lower plantations from inundation, it will, at the same constant rate, make new formations and new soil in the morasses and swamps above, and in time raise all the upper basin to a higher level, drain or expel the waters of its lagoons and lakes, and reclaim for the purposes of agriculture the most favored valley of the two hemispheres for the growth of cotton and sugar. Such is the *rationale* of fact, so far as we know of the past. Reason and the geological history of all similar great alluvial basins confirm its truth. In the progress of civilization, science, and man, the elements are made to subserve his interest and to aid in the preparation of the wilderness and waste places for the expansion of empire and the growth of the human race.

In the Old World the alluviums of Holland and other low countries have been improved and made the most productive and remunerative lands of that continent. Different systems for drainage have been adopted, but they have all been effected at enormous labor, during

long periods of time, and at almost fabulous costs. In the low lands of Holland large lagoons and lakes were emptied by the process of pumping their waters to higher levels, and draining them from such positions by canals and ditches; but years were spent in this slow process, and royal exchequers exhausted. But the vast extent of morass and swamp, and the great volume and surface of water in the lagoons and lakes in the lower Mississippi basin, would render all mechanical means unavailing in the regeneration of wastes of their magnitude. For this reason, I propose to subjugate to use for this great achievement the mighty power of the everlasting flood of the father of waters. That is unchanging, and by its own laws of flow and evaporation and deposit, will in less time perform this plan of reclaiming the wastes of this great alluvial basin than the application of the powers of all known mechanical forces, directed by the highest practical skill of man. I therefore propose "to lay my hand on the main" of this torrent, and, bridling its accumulated waters, tame their normal insubordination, and convert its never-failing power to cumulative use that will profit mankind in all progressive time.

This proposition and its theory will doubtless present itself in a novel and, possibly, startling sense, to many scientific and practical engineers unfamiliar with the geological and topographical peculiarities of the lower basin of this valley, the origin of the principal floods of the Mississippi and its great tributaries.

It is therefore proper that I should bring to their notice, and ask their attention to the habits of all these main supplying waters, and to their influence over the regulation of the great yearly floods that spend their active force and power before reaching the lower bottoms and basins of their "*agua madre.*"

The floods of these tributaries have their origin in rain-tables in remote latitudes from each other, and they are consequently seldom contemporaneous and in confluence.

The melting snows and the rains that swell the Ohio and the water-table of the western slope of the Alleghanies, and the eastern dip of the rolling lands and prairies of Illinois, Indiana, and Ohio, occur long before the flood of the Arkansas, that has its cause in the melting snows of the Sierra Madres of New Mexico and Colorado Territories. The Illinois River, that drains the central and northern prairies of the State, is seldom at its full flow when the melting snows of the extreme north-west and the Hudson Bay region bring down the greater and later drainage from the upper lake country, in the clear water

channel of the upper Mississippi. But the still mightier tide that rolls down the floods from the Yellowstone and the upper sources of the Missouri, having their cause in the thawing, at a still later season, of the eternal snows of the highest mountains of the Cordilleras of Russian America, has its prominent independence of all others, as it has its higher sublimity and power from the vastness of its drainage, and the magnitude of its mountain sources, in ever-increasing snows deposited from the vapor of the great Pacific Ocean, borne on by the prevailing winds from that ocean's coast, and constantly precipitated on the snow-capped tops of mountains where man has not yet trodden. None of these great rivers in their lower and broad valleys, dash down their floods with any of the fury of mountain torrents, suddenly swollen by heavy rains or melting snows; but they roll them thousands and more of miles through broad valleys of gradual and slight slope, after spending their destructive torrent force in higher altitudes and narrow mountain beds, until they meet and mingle in the still broader valley of the Mississippi bottom. Here they become tranquilized as they mix and mingle together, and swell on in greater majesty but less rapid currents through the lower basin; as if hesitating to lose their individuality in the seas that drink them up. In this basin, whose delta-lands are of uniform level, they may be subjugated to the control of man, and spread out by artificial means, having lost the destructive power of torrents and floods precipitated from mountain slopes and high lands.

The rise of the flood-waters of the Mississippi below the mouth of the Arkansas is always by slow degrees, seldom, I believe, to exceed four inches in any twenty-four hours. Artificial banks and dikes confine these waters in their main channel from the mouth of this river to the Gulf. These dikes are constructed with a height intended to prevent any overflow by the highest floods. It is from the mouth of this river that I propose to operate my plan, and from preceding premises my illustrations will now be made more clear. The aprons of my waste-weirs should be constructed at *medium* water-lines. The increased volume of water at highest flood can be estimated, and the extent of morass, swamp, marsh, lagoons, lakes, and bottom surface, it is intended to spread over, can also be calculated. The average days of flood of each year can also be ascertained. The amount of the delta-making material in every thousand cubic feet of flood-water can also be gathered and accurately measured. When these *four* now unknown quantities, that enter into the problem of the plan, are ascer-

tained, the number and extent of the necessary waste-wiers may be sufficiently approximated for all practical purposes, and the problem will be resolved.

To proceed with my demonstration: Suppose the waste-wiers are in proper number, and at proper distances conducted along the entire length of dike from the confluence of the Arkansas with the Mississippi, to the mouth of this last-named river, and the waters gradually rise in flood as they reach the top of the aprons highest up the stream, they flow over the riveted aprons by slow degrees, and seek slowly the lowest levels—the swamps, marshes, morasses, lagoons, and lakes of a basin of vast extent, and of almost unbroken level, and in these they spread themselves out and deposit the material of the delta-making soil, producing in the fruition of its fertilizing nature, the best qualities of cotton and sugar of the world. From the first apron in the series, over which the waters in the beginning of flood commence to waste by trickling over the plank revetments, so inclined as to create little or no current as the waters increase, to the last of the series, the same wasting operation goes on, carrying off the great volume of the flood, and spending its accumulating force and volume by slowly wasting them as they grow, and would otherwise gain resistless strength. Thus they lose the destructive power of confined torrents and floods, as the waters spread out over the vast level surface of this delta basin, and deposit the material for delta-making soil, raising by slow but perpetual increase the elevation of these bottoms, while the water evaporates and is lost.

Perhaps it is a clearer annunciation of this problem, and better illustrates the plan, to call the system of waste-weirs *artificial rivers*, having the capacity to carry off and waste a volume of water equal, or approximating in equality with, the surplus of flood-water over the medium flow of the main channel below the mouth of the Arkansas. *This is substantially my plan.* The undertaking is one of great proportions, and its accomplishment would be of value that cannot be over-estimated. To reclaim the great wastes of the Mississippi basin, to eliminate the creative causes of the epidemics, fevers, and pestilences of the long, broiling epidemical heat of summer there, to convert these wastes into the richest lands of this continent, and at the same time to improve the navigation of the embouchures into the Gulf, are not impossibilities. Nothing short of impossibilities, in their strongest sense, is too great for the energies of the government, and the skill, ingenuity, and practical science of American engineers and

enterprise to accomplish. It should, in my judgment, be undertaken. Time and the elements of this river are the powers and mechanics it is proposed to use, and they will as surely accomplish this purpose as the forces of nature continue in their sure and unchanging laws.

It has appeared to me that the present is a profitable and propitious time to bring this subject to the attention of the country and Congress. The transitive state of things in the South, inviting in that direction the enterprise, energy, and capital of the North, the West, and the Old World, will doubtless develop in the valley of the Mississippi new systems of agriculture, and new plans for the more profitable cultivation of the principal staples of commerce of the Gulf States—cotton and sugar. Lands most productive of the best qualities of these essential necessities to all the conditions, convenience, and comfort of man, will be in constantly increasing demand, and nature, in its progressive creation, seems to be preparing the alluvium of our Gulf States for the supply of the world.

The logic of events should not be mistaken, and in the progress of things, let us wisely apply its reasoning, and prepare for a great future. The experience of the past half century is convincing proof that the Gulf States are to furnish the main supply of cotton and sugar to the world, and the deltas of the Mississippi basins have proved themselves the most productive and profitable soils for the growth of these staples of commerce. It has also proved that they are principal among the sources of revenue, and lead in the agricultural wealth that founds and perpetuates our commercial prosperity.

Should these views present this subject to your mind in a new and more important light than you have heretofore considered it, I beg to suggest the appointment of a board of engineers, eminent in science and practical engineering, to examine into the expediency of the plan here foreshadowed, and that you ask of Congress an appropriation of money to cover the necessary expenses of such surveys and examinations as will enable them to report understandingly on its practicability and estimated cost.

I am, very respectfully, your obedient servant,

B. S. ROBERTS,

Brevet Brigadier-General United States Army.

Hon. E. M. STANTON,

Secretary of War.

COLLIERY SHAFTS.

THE TWO GREAT COLLIERY SHAFTS OF ENGLAND AND AMERICA, VIZ: THE ASTLEY DEEP PIT ON THE DUNKENFIELD ESTATE NEAR MANCHESTER, ENGLAND, AND THE WADESVILLE SHAFT OF THE MAMMOTH VEIN CONSOLIDATED COAL COMPANY NEAR POTTSVILLE, PA.

By the SHEAFER BROS., Mining Engineers, Pottsville, Pa.

THE slope workings of the Mammoth Vein Consolidated Coal Company at St. Clair, in Schuylkill County, Pennsylvania, have reached a depth of 400 yards on an average angle of 19½ degrees south, in the Mammoth Coal bed. Their main gangway westward is now 9600 feet long, commanding an area of about 130 acres of Mammoth Coal, which bed has an average thickness of 30 feet.

The quality of this coal has no superior as a pure white-ash; in fact, it is as nearly simple carbon as is found in the shape of a fuel From this slope of 400 yards, 4 lifts have been worked and the coal hoisted by one engine of 60 horse-power. Two pumping engines are used, one lifting the water 200 yards into a sumpt or reservoir, and the other from this sumpt to the surface. The width of coal from the gangway to the surface increases as the bed crops higher up the mountain going westward, and at the highest point is 1800 feet wide where the main airway of the mine is driven through to the surface, and where the mine is ventilated by an exhaust fan of 12 feet diameter, driven by a steam-engine of 25 horse-power at a rate of 200 revolutions per minute. To get an idea of the ventilation of this colliery a true conception of the magnitude of the inside workings must first be had.

Overlaying the Mammoth bed, with but 15 or 20 feet of slate intervening, is another bed of coal known as the "Seven-foot," the average thickness of which is 10 feet. About 300 yards west of the foot of the slope of the Mammoth bed, a tunnel is driven southward from it into this seven-foot bed, and a gangway driven in it about parallel with the gangway on the Mammoth vein, and quite as far westward. From these gangways, which are nothing more than outlets or passage ways for coal cars, the coal in the two beds is mined out, and the workings, though systematic, ramify in all directions until the whole area is catacombed or mined out. Into and through all these workings there must pass a current of air to supply the workmen, and to carry off the gases that generate in the mine. By aid of the exhaust fan the air is drawn down the slope and through the main gangway until it

reaches the tunnel to the "seven-foot" vein. In the main gangway, just inside of the mouth of the tunnel, a strong door is placed which divides or splits the air current; turning one half of it through the tunnel into the seven-foot workings, and the other half is carried through the workings of the Mammoth bed: near the west end of the mines these two currents are again united, and thence by the fan drawn out to the surface. The area thus ventilated is about 260 acres, or 130 acres on each vein. The seven-foot vein is a clear white-ash coal, a trifle harder and rougher than the Mammoth. It is here, and generally, worked in connection with the former by means of tunnels from one to the other at convenient distances. The extent of the workings very generally conform to those in the lower and larger bed.

There remains necessarily a large amount of unworked coal in the pillars and supports, left to sustain the top or roof of the mines, to give access through it, to ventilate it and to drain it; nevertheless, with a thickness of 25 feet in the Mammoth bed and 10 feet in the seven-foot bed, the yield of coal must be very great, every acre producing, if gleaned perfectly clean, 56,446 tons. The product of this colliery, since 1848, is as follows:

	TONS.		TONS.
1848	37,744	1858	104,087
1849	37,013	1859	127,020
1850	56,397	1860	116,118
1851	70,253	1861	92,236
1852	70,366	1862	122,645
1853	78,502	1863	98,579
1854	107,311	1864	35,726
1855	120,894	1865	48,846
1856	116,973	1866	85,109
1857	81,135		

An average of 84,576 tons yearly for nineteen years, and a total of 1,606,955 tons. The waste, however, is very great; nearly one-half is an entire loss. No gleaner can recover it, and no men, not even whalers, are more venturesome than miners: braving the dangerous explosions of fire-damp, or the equally fatal choke-damp, the blasts of powder and falling masses of coal and rock, their lives are beset with hourly dangers.

"Robbing a mine," as it is technically called, is the attempt to remove the pillars of coal left between the chambers to support the top; this this is an exceedingly dangerous operation. These columns of coal stand but 10 or 12 yards apart for a mile in length and a hundred

yards in width; they support an enormous pressure of rock, slate and earth. Blasting them away, brings down a mountain and endangers all within its influence, sometimes in detached falls of tons of rock, at other times the whole space gradually settles down with a terrible slow weight and awful groaning, and at other times it comes with a terrific shock and a mighty rush of wind, driven out with the violence of a storm. To avoid this older and catacombed part of the mines, this enterprising company were induced to open into a larger body of coal, one mile to the south-west, by means of their Wadesville shaft, 666 feet deep, to the Mammoth bed. The selection of this point was made after very careful survey, for several substantial reasons. 1st. To secure a very large body of good coal, at a reasonable depth, partially opened by the slope already mentioned. 2d. Locating it on the E. Norwegian Branch Railroad, places it but 2 miles from the head of the Reading Railroad at Pottsville, and the nearest to tide-water at Philadelphia of any of the 152 collieries shipping over the Reading Railroad, or the Schuylkill Navigation in 1866. We dwell a moment to consider this point. The railroad and canal terminate near Pottsville, on the southern edge of the southern coal field, about midway of its termini, the one 30 miles east, on the Lehigh River, at Mauch Chunk, and the other about 30 miles to the west, near Dauphin, on the Susquehanna River. From the head of the railroad, 94 miles, and from the head of the canal, 108 miles, tide-water, branch railroads ramify and reach, like ten fingers from the end of two long and strong arms, gathering in the fossil harvests of past ages. The product in 1866 from 152 collieries, was

nearly 4,500,000 tons.

Fifty-three of these collieries lie in the Mahanoy region, north of Pottsville, from 8 to 20 miles distant, and produced ..... 2,500,000 "

The balance ..... 2,000,000 tons,

came from the 99 collieries south of the Broad Mountain, and varied in distance from 2 to 12 miles from the head of the road. Of all these 152 collieries, the above shaft is the nearest to market.

The site of the shaft was carefully chosen with reference to the geological structure of the district, and is exceedingly important, being on the long and gentle southern slope of the great Mine Hill anticlinal axis, which enables us to reach the Mammoth bed with a practical depth, and obtain a working length limited only by land boundaries or leases. This shaft commands a working length of coal miles in ex-

tent, but is at present limited by a lease, eastward 500 yards, and westward 900 yards, or 1400 yards in all, and a breadth of 667 yards, north and above the water drainage at foot of shaft. This length, multiplied by the breadth, and again by the great thickness of the Mammoth Vein—10 yards—gives a cubic quantity equal to 6,000,000 cubic yards or tons, to which we add the seven-foot bed, averaging three yards in thickness, and the four-foot bed overlaying the second foot, averaging $1\frac{1}{2}$ yards, equal to 2,701,350, gives a total quantity of 8,704,350 tons, and of this immense quantity the ton furthest removed from the foot of the shaft is 1350 yards, and as this ton of coal is passing to the shaft (its route is over a self-acting plane of 470 yards in length), the haul by mule-power will be but 880 yards, a matter of the greatest moment in the cheap production of coal. This central position of the shaft does away with the long and tedious hauls, and the expensive gangways now so common in slopes and drift workings.

With reference to the details of the shaft itself, work began upon it September 7th, 1864. The surface covering was removed, making an excavation 22×30 feet, and 40 feet deep to the first stratum of solid rock, using it as a foundation. A wall 4 feet in thickness and 14×22 feet inside of enclosure was carried up to the surface, and of this size the shaft was sunk. The severe winter weather delayed the masonry, and consequently the sinking, until June 12th, 1865. 12 days were lost in making sumpt for the Orchard Vein, 115 feet from surface; also, 18 days in making sumpt in Primrose Vein, 320 feet from surface; again, 15 days in lowering pump from one sumpt to another, 12 days we were drowned out, 18 days men turned out, 6 days adjusting pump; then, from the 19th of October, 1866, to the 26th of February, 1867, and 12 days in May and June, 1867. Making a total delay from June 12, 1865, of 203 working days. The Mammoth Vein was cut June 18, 1867, 2 years and 6 days, or 631 working days from June 12, 1865; deduct time lost, 203 days, and there remains 428 days spent in sinking from bottom of foundation walls to top of Mammoth Vein, a distance of 623 feet, or $1\frac{45}{100}$ feet per day. The shaft is divided into three compartments of 6×12 feet by 12 inch timbers placed about 4 feet apart, from top to bottom.

The surface water is caught by drains cut around the shaft, and by them is conducted into the sumpt in the Primrose Vein, from whence it is hoisted 320 feet by an eight inch pump to the surface. Below the Primrose there is so little water that a pump is not at present necessary to collect the small quantity made at the bottom of the shaft, but is hoisted by buckets, and is not over 60 gallons per day.

During the sinking of the shaft no artificial means of ventilation were used, nor is there now, although the gangway is 200 feet west, from the foot. Ordinarily, in sinking a well 60 feet deep, ventilation is difficult, but at this shaft a simple contrivance and a partition in the shaft so creates a draught that pure air is abundant at the face of of the gangway, and everywhere through the workings. English collieries frequently sank an extra shaft for ventilation.

With reference to the capacity of this shaft, we beg to show what others have and are doing abroad. As our experience in the Pennsylvania coal is limited thus far, and merely experimental, we select from among the principal English collieries as follows, premising what they can do at great depths, we can do more readily at less.

Name.	Owner.	Depth.	Capacity per day.
Houghton Pit,	Lord Deedam,	260 yards,	1170 tons.
Daton Deleval,	J. E. Foster,	224 "	1000 "
North Seaton,	J. B. Foster,	248 "	1200 "
Ryhope Col.,	John Taylor,	560 "	2000 "
Dunkenfield,	.....	686½ "	500 "

This latter shaft furnishes a striking example of the enterprise of English capitalists, and is in good contrast with our American shaft. Work upon it began in 1847; at the end of five years it reached the depth of 476 yards. In July, 1858, ten years after its beginning, the shaft had obtained a depth of 2059½ feet, or 686½ yards. The material sunk through is—

Rock	211 yards.
Shale	443½ "
Coal	32 "
Total	686½ yards.

From the bottom of this shaft a slope is sunk 250 yards at an angle of one foot to the yard, making the total depth 936½ yards, and the vertical height 770 yards from the surface. Much difficulty was experienced from meeting with springs of water. For 29 months the progress of the sinking was but 17 feet per month.

The general diameter was 12 feet, at the centre 12½, to allow for passing, and at the bottom it was enlarged to 19 feet 2 inches. It is tubed with cast iron segments for a distance of 42 yards, then lined with a 9 inch wall of arch bricks, stiffened at intervals with stone rings, 18 inches on the bed and 12 inches thick, of which there are 80; altogether

7308 cubic feet of stone and 750,000 brick have been used in the shaft, exclusive of those used in the mouthings. The total cost was $500,000 and developed 32 yards of coal in 26 seams of more than a foot in thickness, 15 of which have an aggregate thickness of 58½ feet.

This enterprise was successfully completed by winning the "Black Mine," a fine seam of coal 4 feet 8½ inches thick and calculated to last 30 years at 500 tons per day. We may infer, therefore, that the grand object of this immense undertaking was to develop the "Black Mine" coal, 4 feet 8½ inches thick.

The American shaft develops but ten seams of coal, as follows:

1.	The Coal	at	40	feet	deep,	1 foot thick.
2.	" "	"	94	"	"	4 feet "
3.	" Orchard	"	115	"	"	6 " "
4.	" Coal	"	313	"	"	1 foot "
5.	" Primrose	"	320	"	"	10 feet "
6.	" Holmes	"	402	"	"	4 " "
7.	" Rough vein	"	490	"	"	4 " "
8.	" Four-foot seam	"	627	"	"	6 " "
9.	" Seven-foot seam	"	639	"	"	10 " "
10.	" Mammoth	"	669	"	"	30 " "
						76 feet.

Its object, however, was to win the Mammoth and Seven-foot coals, together with 40 feet, and all the most productive and reliable beds of the Anthracite regions; they, at the depth of 222 yards, or less than ⅓ that of the "Black Mine," can certainly send to the surface double the estimated quantity of the latter, or 1000 tons per day. We then shall assume 500 tons per day for 300 days, or 150,000 tons per annum for the English mine, and 300,000 tons per annum for the American mine.

To pay the interest on the English investment, say 6 per cent. on $500,000, would impose a tax of 20 cents per ton on the product of the mine, exclusive of the interest on the original cost of the land. The cost of the American pit was $147,50 per linear foot of depth; making, for the 666 feet, including

Cost of temporary hoisting-engine	$98,231 10
Cost of permanent hoisting and pumping engines, and other outside improvements	50,000 00
	$148,231 10

The interest on this cost of, say, $150,000 or $9000, is equal to a tax of 3 cents per ton on the yearly product of the mine.

The English estate contains 1263 acres to glean; the American, in an area of 200 acres, has 8,704,350 tons, or, deducting 1000 tons for waste per day for 20 years, ⅓ more coal in ⅛ the area of the English mine.

In this connection, we beg leave to show the product of the English mines, and the Pennsylvania anthracite for the last four years.

	English. Tons.	Penn'a. Tons.
1863	88,292,515	9,631,101
1864	92,789,878	10,184,320
1865	98,150,587	9,652,391
1866	101,630,543	12,703,883

Coal Areas.	Square Miles.
Bituminous of United States	133,132
" " British America	18,000
" " Great Britain	8,139
Anthracite of Great Britain and Ireland	3,720
" " Pennsylvania	470

If we thus contrast the comparatively small amount of Pennsylvania anthracite, its easy and cheap development and production, and its convenient access to the sea-board, we must be impressed with its great inportance and consequent value.—*Miners' Journal.*

THE U. S. SURVEY OF THE NORTH AND NORTH-WEST LAKES.

This survey, although not so widely known throughout the country as the admirable U. S. Coast Survey, while engaged upon the Atlantic shores, is a national work of a highly scientific character, which is only seconded, if even excelled in this country, by the latter. The original and immediate object of this survey has been the production of charts to be issued to chartered boats navigating the lakes, to which they are furnished free of charge by application of the proper officer to the superintendent of the survey, at the office in Detroit.

The survey has been conducted under the auspices of the War Department, and under the superintendence of some officer of the corps of U. S. Engineers. During the past year, the field work has been confined principally to Lake Superior, where a small force has been employed for several preceding years. The greater part of the shore line and shore hydrography of the southern coast has been surveyed, which is soon to be reduced to a chart. A base line about five miles

long has just been measured with great care on the west shore of Keweenaw Bay, from which the main triangulation is to be extended over nearly the whole of the great lake. This work has been progressing favorably for two years, for which the high points upon the coast overlooking the broad sheet of water offer an inviting field. The three angles of a remarkable triangle in this chain have been measured the past season, the sum of which vary less than half a second of arc from the truth; remarkable from the fact that it is the finest in shape for its size, and the largest ever measured on the continent, if not in the world.* The lines of this triangle twice cross the lake, one angle being located on Keweenaw Point; a second on Isle St. Ignace, nearly north of the first, and adjacent to the north shore; and the third on the north-east coast, about six miles from shore, and about forty miles north of Michipicoten Island. The length of two of the lines of this great triangle is about ninety-three or four miles, and of the third over one hundred and one. The height of the stations was not sufficient to allow the line of sight to pass above the water, the land upon the opposite shore being entirely invisible in ordinary times. The measurement of these angles with such accuracy, in the face of so many difficulties, must be regarded as a remarkable triumph.

Three parties, one at each station, were charged with the duty of measuring the angles if possible, and of making astronomical observations for the latitude and longitude. The difference of longitude resulted from the local time given by the observations, and the comparison of the chronometers by powder flashes made at the stations alternately. Half a pound of rifle powder was at times fired at a flash. A flash of a third of a pound can be seen a hundred miles in a clear atmosphere. Mirrors were used for heliotropes, which presented a reflecting surface of about two-thirds of a square foot, with which rays of sunlight were thrown from one station to another, toward which the instruments were directed in measuring the angles. Smaller mirrors were tried, which failed. The former were clearly seen with the telescopes, and where the line of sight passed considerably above the surface of the lake, were discernible with the naked eye; but on the longest line, between Keweenaw Point and the north-east coast, nothing could be seen across except where the rays from the opposite

* In the Ordnance Survey of England, eleven sides of triangles exceeded 100 miles, one of which was 111 miles; but I am not aware that any two of them belonged to any triangle.

shore were bent by refraction or *mirage*, which but rarely occurred; necessitating constant watchfulness on the part of the observers.

The appearance of the signals was varied and interesting. Refraction partially decomposed the light thrown by the heliotropes, and caused it to twinkle in colors like a bright star at low altitude, so that instead of appearing constant, varied in brightness at intervals no greater than a quarter of a second; as though the advanced portion of certain rays was checked by transmission until a higher degree of intensity was acquired which could pierce the opposing medium. Cannot this irregularity be ascribed in a great measure to a difference of velocity with which the several elements of light may be projected? Of course, the stream of light was more steady on shorter lines, or those more elevated, where the rays met with less refraction and decomposition. At times the heliotrope spark would appear as several bright points, one above another, and frequently united into a column of light by the effect of *mirage*. This also would often appear much inclined, and would vary its position right and left through a space of about half a minute of arc, to the great annoyance of the observers. This would seem to prove beyond a doubt the existence of lateral refraction, especially on long lines which pass near a water surface.

The appearance of the powder flashes, as observed on the longest line, were not always bright and distinct, but alternated like twilight after sunset, as it would be very natural to suppose, inasmuch as the line of sight passed considerably below the surface of the water in ordinary times, and the direct rays from the flash may have been invisible. These flashes, although made in the night-time, also experienced some of the phenomena above cited in connection with the heliotrope flash.

During the past season, the field work for determining the flow of several large rivers has been performed; including the St. Mary's near the canal, the St. Clair, the Niagara near its mouth, and the St. Lawrence near Ogdensburg. This is a new and interesting feature of the Lake Survey, and if the work be continued with the zeal which has characterized it thus far, must contribute additional and valuable information to the science of hydraulic engineering. It is the intention to make the experiments sufficiently extensive to establish, independently, theories for the flow of streams; after which they will be compared with those that have resulted from other experiments.

S. W. R.

Mechanics, Physics and Chemistry.

(Concluded from page 276.)

LECTURES ON MINERALOGY.

By Theodore D. Rand.

LECTURE IV.

PHŒNIXVILLE, CHESTER VALLEY, WEST CHESTER, PENNSBURY, WOOD'S CHROME MINE, TEXAS, GAP MINE.

In this lecture I purpose considering a few of the more important localities more distant than those heretofore described, but still readily accessible from Philadelphia.

The first of these is the mining region of Phœnixville, Chester County. There are several mines in this neighborhood, including the Perkiomen mines on the north-east side of the river, the Wheatley, the Morris, the Chester County, the Charlestown and others on the north-west side. Of these the Wheatley is the most important, in regard to both ores and minerals.

The veins, according to Prof. Rodgers, belong to a group of lead and copper bearing lodes, ranging in a general east and west direction. The individual veins are remarkable for their mutual parallelism, their average course being about north 31°–35° east by compass. They are true lodes or mineral injections filling dislocations or fissures transverse to the general direction of the strata which they intersect. The metalliferous belt ranges not far from the boundary which divides the gneissic or metamorphic rocks of Chester County from the middle secondary red shale or sandstone strata.

The vein at the Wheatley mine varies in thickness from a few inches, to about 2½ feet, and averages probably 18 inches. The veinstone is generally a decomposing granite composed of quartz and feldspar chiefly, or a red shale with calc spar, quartz and rarely fluorspar.

The minerals of this mine are numerous and of unusual beauty. They are as follows:

Lead.—Galena, in cubes, octahedra and cubo-octahedra; also massive, fibrous and granular, containing about thirty ounces of silver to the ton.

Sulphate of lead (*anglesite*), of which probably the finest crystals in the world have been found here. Beautiful transparent crystals

an inch in length are not uncommon, and some of less beauty, five inches in length and one and a half in thickness, occur.

Carbonate of lead (*cerusite*), in crystals less wonderful than the preceding, but still remarkable, some being an inch in length and transparent. More rarely it occurs in beautiful specimens, coating crystals of the sulphate.

Molybdate of lead (*wulfenite*), containing at times a small quantity of vanadate of lead, giving a bright red color erroneously attributed to chromic acid. At one time this was abundant.

Vanadate of lead (*vanadinite*). This very rare mineral occurs sparingly as a dark crystalline crust on quartz and ferruginous clay, associated with the molybdate.

Phosphate of lead (*pyromorphite*), in probably the finest crystallizations in which it has ever been found. It is exceedingly abundant, and has been smelted in large quantities as an ore, although previous to its discovery at this mine it was a comparatively rare mineral.

Arsenate of lead (*mimetene*), occurs very rarely in colorless or pale yellow crystallizations.

Tungstate of lead (*scheeletine*), in yellowish-gray octahedra on quartz with phosphate and molybdate of lead.

Copper.—Native copper, rarely and only in thin films.

Copper pyrites, not uncommon; sometimes, but rarely, well crystallized.

Chrysocolla, black oxide of copper, malachite, azurite, covelline and chalcotrichite in small quantity.

Zinc.—Blende, the sulphide of zinc, in large quantity and very large crystals, which, however, are rarely distinct. Very fine specimens and a few distinct octahedral crystals have been obtained. It is not smelted as it has not been found profitable.

Carbonate of zinc (calamine or smithsonite) is found in delicate silky tufts; also silicate of zinc or silicious calamine in botryoidal masses.

Calcspar, in very beautiful varieties, is found abundantly; also, more sparingly, fluorspar, the former sometimes including crystals of the latter.

Finely crystallized quartz occurs; also brown hematite, stilpnosiderite, oxide of manganese, iron pyrites, sulphate of baryta, dolomite, sulphur, probably resulting from the decomposition of galena, brown spar or carbonate of lime and iron, pearl spar. One or two fine specimens of quartz pseudomorphous after calcite have been found.

The other mines yield the same minerals, or many of them, but in less quantity and poorer specimens. The Perkiomen Mine yields chiefly ores of copper, among them the rare phosphate phosphorochalcite, which has not, I believe, been previously described from this region. At the Morris Mine, near Phœnixville, and at one or two small openings near the Perkiomen Mine, sulphate of baryta is very abundant, but the specimens are not remarkable.

Running nearly at right-angles to the valley of the Schuylkill, a few miles south-east of Phœnixville, is the Chester Valley, of altered limestone, probably of the Trenton period, flanked on the south by a high hill, chiefly of primitive rocks, gneiss, mica schist, chlorite schist, &c., and on the north by a still higher range, chiefly of white sandstone, similar to that near Spring Mills, of the Potsdam and Primal period. Numerous limestone quarries have been opened in this valley. One of them, near the steamboat station on the Pennsylvania Railroad, and now owned by E. Dunbar, has yielded excellent marble. Much of the marble used for the Custom House on Chestnut Street, was obtained from this quarry.

At several localities in this vicinity brown hematite iron ore of good quality has been found. Nearly all of it is smelted at Conshohocken and Spring Mills. At a mine near Turnpike Station allophane and gibbsite have been found. A short distance north-east, crystallized and stalactitic wavellite, in remarkably fine specimens, was at one time abundant, but the mine has not been worked for some years. This wavellite is probably the finest in the world.

Further west, near Parksburg, rutile is found in loose masses, sometimes embedded in quartz, but more commonly isolated crystals, often of unusual size and beauty. It has been gathered in quantity by the farmers from their ploughed fields, and has been largely consumed by manufacturing dentists for coloring artificial teeth. It is now becoming rare.

One mile north of West Chester is a serpentine ridge, in which several quarries have been opened for building-stone. At all of them arragonite, sometimes in fine stellated forms, occurs. It has been called magnesite; but though occurring in the midst of magnesian rocks, contains no magnesia. At Taylor's Quarry very distinctly characterized kerolite occurs in a horizontal vein or bed, about three-quarters of an inch thick, intermingled with the stellated arragonite.

About three miles south of West Chester, clinochlore is found in fine crystals embedded in talc, filling cavities in a compact massive

serpentine. About fifty yards west of this is found the jefferisite. It was found in a vein at the surface of the ground associated with decomposed feldspar. It is in hexagonal prisms, with distinct basal and frequent prismatic cleavage.

Six miles west of West Chester, at the Poor House Quarries, in cavities in limestone, are found rutile, in crystals generally acicular, but sometimes an eighth of an inch in diameter and an inch long and perfectly transparent, and chesterlite, in very fine crystallizations; also mountain leather and fine yellow margarodite.

About four miles south of this locality, and one and a half north-east of the town of Unionville, is the celebrated corundum locality. Many tons of the mineral have been obtained. At one place it was mined for a depth of about 30 feet, but at present it is found in loose masses only, generally massive, intermingled with emerylite. The corundum is occasionally well crystallized, but more frequently occurs in large and very tough masses, sometimes of several tons weight, showing indistinct cleavage. Seams in these masses are lined with emerylite, often in distinct crystals and very fine specimens, associated sparingly with the rare mineral diaspore, or hydrate of alumina, discovered by Messrs. Lea and Jefferis about two years ago. The specimens are unusually fine. Mr. Lea has one perfect crystal, doubly terminated, nearly an inch in length. The corundum is occasionally found in a white granular albite, which, although apparently a pure mineral, possesses a much greater degree of hardness than usual. Black tourmaline and several other minerals occur, but not in fine specimens. Near by is a locality of beryl, which has yielded some of remarkable size. Mr. Jefferis, of West Chester, possesses one of very good color, weighing upwards of twenty-five pounds. In the limestone quarries of this region are found at times fine light brown tourmaline, foliated, fibrous and asbestiform tremolite, phlogopite, necronite, arragonite, vermiculite, &c. At a quarry of hornblendic gneiss, near Kennett Square, remarkably fine sunstone, with zoisite and epidote, and the acadiolite variety of chabazie, occur.

In Pennsbury Township, on J. Dilworth's farm, there is a vein of mica—muscovite—which has yielded very remarkable crystals abundantly. They are perfect hexagonal prisms, sometimes with prismatic cleavage, and sometimes with included black bands parallel with the sides of the prism. They have been found six inches in diameter. The vein is on the side of a small hill in a cultivated field, and has been dug out to a considerable depth, but is probably by no means exhausted.

Near Chaddsford, chondrodite and sphene with pyroxene occur in limestone.

In the southern part of Chester and Lancaster Counties, bordering on Maryland, are several interesting localities occurring in an extensive bed of serpentine. The appearance of the country is remarkable. Riding along the road, in some places on the right, is soil derived from gneissic rocks, bearing most luxuriant crops of grass and grain; on the left, the bare yellowish serpentine, washed into deep gullies by the rains and supporting a few stunted pines, and a few plants peculiar to these rocks where a slight covering of earth exists, but looking barren and desolate in the extreme.

In Maryland, near the line and east of the Octorara Creek, considerable veins of carbonate and silicates of magnesia (magnesite, deweylite and meerschaum) exist, and have been largely mined to be used for the manufacture of epsom salts. The product for this year (1867) is estimated at nine hundred tons. The magnesite is amorphous, white and very tough. The deweylite varies greatly in appearance, being from colorless and nearly transparent to almost black and opaque; very fragile.

At one opening, a white feldspar, with imperfect cleavage, sometimes compact and almost without cleavage, sometimes fine granular and rarely opalescent (moonstone), appears to be passing into deweylite by alteration. This change is remarkable, and merits investigation.

In the south-east corner of Lancaster County, near the Octorara, are two mines of chromic iron. One of these (Carter's) is but about 120 feet deep. It is yielding a large quantity of chromic iron of good quality. It affords the mineralogist several interesting species, deweylite, hydro-magnesite, hydro-dolomite, emerald nickel, pennite and a massive brick-red serpentine. The other mine, about 150 yards west, is the well-known Woods' mine, made famous in mineralogy by the magnificent crystallizations of brucite or hydrate of magnesia, for which it is unequalled. It is 700 feet in depth, and has yielded an immense amount of chromic iron. The vein was very irregular—at one place 20 feet in width—then running into mere strings and again widening out. Excavation downward has ceased, it being believed that the ore is practically exhausted. Much ore is still being extracted from ramifications of the principal vein. Besides the brucite and chromic iron, emerald nickel, nickel gymnite, pennite, hydro-magnesite, hydro-dolomite, dolomite, magnesite in sparry masses resembling dolomite,

arragonite, in fine radiated crystallizations, baltimorite, metaxite, rhodochrome, marmolite, rhodophyllite and picrolite are found. At Low's mine, on the Maryland line, two miles further west, the beautiful variety of serpentine known as williamsite was formerly abundant with kammerrerite, rhodochrome and several of the species found at Woods'. The mine has not been worked recently.

About a mile west of Texas, on the farm of M. Boyce, occur altered pyrites in fine crystallizations. They occur loose in the soil or embedded in a soft chlorite schist—all the crystals in any one piece of the schist are of the same form, but another piece may be picked up alongside of the first, containing crystals of a very different form, except that the easternmost, almost without exception, are *cubes*. The other forms are octahedra and pentagonal dodecahedra, with all intermediate forms, some crystals having all the planes of the cube, octahedron and dodecahedron.

At the Gap Mine, in the eastern part of Lancaster County, the valuable ore is magnetic pyrites, containing about two per cent. of nickel. Sulphide of nickel or millerite, the very rare sulphate of nickle or pyromeline, copperas, carbonate of iron, marcasite and iron sinter (subsulphate) occur at this mine.

At Mullica Hill, N.J., vivianite is found abundantly in beautiful specimens lining belemnites (mullicite) and other fossils, or rather, replacing the carbonate of lime of which they were originally composed.

We have thus considered the prominent localities of our region, the purpose with which we set out. I hope that students of the science may by these lectures be aided in collecting specimens for their cabinets, as the indefinite manner in which localities are too often described have doubtless deterred many from a search. As an example, a standard work on Mineralogy gives one locality, as "*on the railroad near Philadelphia*," with others not much more definite.

From the Proceedings of the Royal Society, No. 87.

SPECTROSCOPIC OBSERVATIONS OF THE SUN.

By J. Norman Lockyer, F.R.A.S.

The two most recent theories dealing with the physical constitution of the sun, are due to M. Faye and to Messrs. De la Rue, Balfour Stewart and Loewy. The chief point of difference in these two theories is the explanation given by each of the phenomena of sun-spots.

Thus, according to M. Faye,* the interior of the sun is a nebulous gaseous mass of feeble radiating power, at a temperature of dissociation; the photosphere is, on the other hand, of a high radiating power, and at a temperature sufficiently low to permit of chemical action. In a sun-spot we see the interior nebulous mass through an opening in the photosphere, caused by an upward current, and the sun-spot is black, by reason of the feeble radiating power of the nebulous mass.

In the theory held by Messrs. De la Rue, Stewart and Loewy,† the appearances connected with sun-spots are referred to the effects, cooling and absorptive, of an inrush, or descending current, of the sun's atmosphere, which is known to be colder than the photosphere.

In June, 1865, I communicated to the Royal Astronomical Society‡ some observations (referred to by the authors last named) which had led me independently to the same conclusion as the one announced by them. The observations indicated that, instead of a spot being caused by an *upward* current, it is caused by a *downward* one, and that the results, or at all events, the concomitants of the downward current are a dimming and possible vaporization of the cloud-masses carried down. I was led to hold that the current had a downward direction by the fact that one of the cloud-masses observed passed in succession, in the space of about two hours, through the various orders of brightness exhibited by *faculæ*, general surface and *penumbræ*.

On March 4th, of the present year, I commenced a spectroscopic observation of sun-spots, with a view of endeavoring to test the two rival theories, and especially of following up the observations before alluded to.

The method I adopted was to apply a direct vision spectroscope to my 6¼-inch equatoreal (by Messrs. Cooke & Sons) at some distance outside the eye-piece, with its axis coincident with the axis of the telescope prolonged. In front of the slit of the spectroscope was placed a screen on which the image of the sun was received; in this screen there was also a fine slit corresponding to that of the spectroscope.

By this method it is possible to observe at one time the spectra of the umbra of the spot and of the adjoining photosphere or penumbra. Unfortunately, however, favorable conditions of spot (*i. e.* as to size, position on the disk, and absence "of cloudy stratum"), atmosphere and instrument are rarely coincident. The conditions were by no means all I could have desired when my first observations were made, and, owing to the recent absence of spots, I have had no opportunities of repeating my observations. Hence I should have hesitated still

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* *Comptes Rendus*, vol. lx., pages 89, 138, abstracted in the *Reader*, February 4th, 1865.

† *Researches on Solar Physics*. Printed for private circulation. Taylor & Francis, 1865.

‡ *Monthly Notices Roy. Ast. Soc.*, vol. xxv., page 237.

longer to lay them before the Royal Society had not M. Faye again recently called attention to the subject.

On turning the telescope and spectrum apparatus, driven by clockwork, on to the sun at the date mentioned, in such a manner that the centre of the umbra of the small spot, then visible, fell on the middle of the slit in the screen, which, like the corresponding one in the spectroscope, was longer than the diameter of the umbra, the solar spectrum was observed in the field of view of the spectroscope with its central portion (corresponding to the diameter of the umbra falling on the slit) greatly enfeebled in brilliancy.

All the absorption bands, however, visible in the spectrum of the photosphere, above and below, were visible in the spectrum of the spot; they, moreover, appeared thicker where they crossed the spot-spectrum.

I was unable to detect the slightest indication of any bright bands, although the spectrum was sufficiently feeble, I think, to have rendered them unmistakably visible had there been any.

Should these observations be confirmed by observations of a larger spot free from "cloudy spectrum," it will follow, not only that the phenomena presented by a sun-spot are not due to radiation from such a source as that indicated by M. Faye, but that we have in this absorption hypothesis a complete or partial solution of the problem which has withstood so many attacks.

The dispersive power of the spectroscope employed, was not sufficient to enable me to determine whether the decreased brilliancy of the spot-spectrum was due in any measure to a greater number of bands of absorption, nor could I prove whether the thickness of the bands in the spot-spectrum, as compared with their thickness in the photosphere spectrum, was real or apparent only.*

On these points, among others, I shall hope, if permitted, to lay the results of future observations before the Royal Society. Seeing that spectrum analysis has already been applied to the stars with such success, it is not too much to think that an attentive and *detailed* spectroscopic examination of the sun's surface, may bring us much knowledge bearing on the physical constitution of that luminary. For instance, if the theory of absorption be true, we may suppose that in a deep spot, rays might be absorbed which would escape absorption in the higher strata of the atmosphere; hence also the darkness of a line may depend somewhat on the depth of the absorbing atmosphere. May not also some of the variable lines visible in the solar spectrum be due to absorption in the region of spots? and may not the spectroscope afford us evidence of the existence of the "red flames" which total eclipses have revealed to us in the sun's atmosphere, although they escape all other methods of observation at other times? and if so, may we not learn something from this of the recent outburst of the star in Corona?

* Irradiation would cause bands of the same thickness to appear thinnest in the more brilliant spectrum.

From the London Engineering, October, 18, 1867.

MR. JOHN A. ROEBLING

WAS born on the 12th of June, 1806, in the city of Mülhausen, in Thüringia, Prussia. After the usual academical education, he visited the Royal Polytechnic School at Berlin, receiving the degree of Civil Engineer upon the completion of his studies. This obliged him to remain three years in the service of the State, most of the time being spent in the superintendence of public works in Westphalia.

Emigrating to the United States in 1831, he settled in the neighborhood of Pittsburg, in western Pennsylvania, almost the frontier region of the far West at that time, purchased a tract of wild land, and devoted himself for several years to reclaiming it and building up a small country town. The life of a farmer proving rather monotonous to one educated for an engineer, he embraced the first opportunity which offered, to enter again upon the pursuits of his profession.

Extensive canal and slack-water improvements were then in progress in most of the States of the Union, and he obtained his first situation in America, as assistant engineer on the slack-water navigation of the Beaver River, a tributary of the Ohio. This was followed by an engagement on the Sandy and Beaver Canal, a work intended to connect the waters of Lake Erie with the Ohio River, but never completed, both from lack of means and from the opposing influence of the rising era of railways. The last employment on works of this kind was on the Upper Alleghany River, where he located a feeder for the Pennsylvania State Canal. The time had now passed by for building canals, and railways were the order of the day. Entering the service of the State of Pennsylvania, he was employed for three years in surveying and locating three lines of railway across the Alleghany Mountains, from Harrisburg to Pittsburgh, the road being ultimately built by the Pennsylvania Central Railway Company, not a State enterprise.

A short period of rest from public works was devoted to commencing the manufacture of wire-rope, a business in which he was the pioneer in America, and occupies the first place to this day. The introduction of these ropes on the inclined planes of the old portage railroad, on which the canal boats of the Pennsylvania State Canal were transported across the Alleghany Mountain-range, was attended by the usual opposition incident to the introduction of anything new, and necessitated the rebuilding of the machinery by him in a style adapted to wire rope.

It was in this manufacture that the necessary experience was gained in regard to the nature and qualities of wire, and the practical application and handling of the material, an experience soon to be brought into play in the construction of the first suspension aqueduct in the United States.

The general idea of suspension bridges had been a favorite one with

him ever since the college days, when it formed the subject of the graduating thesis; a suitable opportunity was merely wanting to carry them out in reality.

This was offered in the year 1844, at Pittsburgh. The wooden aqueduct of the Pennsylvania Canal, across the Alleghany River, having become so unsafe as to require its removal, and the erection of a new structure on the old piers, the time being limited to nine months, including the winter season of 1844–'45. The work was let by contract to the lowest bidder, who proved to be Mr. Roebling. It was carried to a successful completion by him within the time specified, and opened to commerce in May, 1845.

This aqueduct comprised seven spans of 162 feet each, consisting of a wooden trunk to hold the water, and supported by a continuous wire cable on each side, of 7 inches in diameter.

A rigorous winter and an unusually rapid river added greatly to the difficulties to be overcome, heightened as they were by the entire novelty of the method of construction, and by the unavoidable imperfections of hitherto untried cable machinery, intended for the first time to make a large cable in the place it was to occupy permanently.

One satisfactory phase, however, in the history of that work, and indeed of a subsequent one also, was the practical refutation its success afforded to the numerous attacks of the engineering profession of that day, who scouted at the bare idea of a suspension aqueduct, and predicted its downfall as soon as the water was let into it.

Following the building of the aqueduct, came the erection of the Monongahela Suspension bridge at Pittsburgh, on the piers of the old wooden bridge destroyed by the great fire of 1844; it connects that city with the borough of Sligo, and consists of eight spans of 188 feet each, supported by two 4½ inch cables, which in this instance were made on land separately for each span, and then hoisted in place from flatboats. In this bridge the pendulum principle was applied to counterbalance adjoining spans under the action of unequal loads.

In 1848 Mr. Roebling undertook the construction of a series of four suspension aqueducts on the line of the Delaware and Hudson Canal, connecting the anthracite coal regions of Pennsylvania with the tide-water of the Hudson River; they were all completed in the course of two years, as follows:

Lackawaxen Aqueduct,	2	spans of	115	feet each,	and two	7	inch cables.		
Delaware	"	4	"	134	"	"	8	"	"
High Falls	"	1	"	145	"	"	8½	"	"
Neversink	"	1	"	170	"	"	9½	"	"

They are all essentially permanent works, as merely the woodwork of the trunk requires occasional renewal.

During this period Mr. Roebling removed from the West, establishing his works and his residence at Trenton, in the State of New Jersey.

Public attention had, for some time past, been directed to the prob-

lem of connecting the New York Central and Great Western Railway of Canada by bridging the chasm of the Niagara River, a problem which, from the nature of the locality, admitted of no other solution than by a railway suspension bridge. A company had been formed several years for that purpose, and had selected Mr. Ellet for their engineer. Under his superintendence a temporary bridge was erected at the site, for foot-travel and light carriages: this was in use several years, being subsequently removed. When, however, the time arrived for commencing the main work, Mr. Ellet had become involved in personal difficulties with the company, and left them. Mr. Roebling was then invited to make plans and estimates for the bridge, and was at the same time appointed the engineer.

For four years, commencing with 1851, the work was continued without interruption even during the coldest Canada winters, until, in March of 1855, the first locomotive and train crossed a railway suspension bridge; and it may be safely said that up to the present day it is still the only example of the kind of any magnitude.

It is needless to enter into any details of construction here, as the structure is too well known; it will be sufficient to state that it has a clear span of 825 feet, is supported by four wire cables of 10 inches diameter each, and has two floors, the lower one devoted to vehicles and the upper one to the railway trucks. These two floors are connected by struts and diagonal tension rods, so that the superstructure forms, in fact, a continuous hollow girder, stiff enough to support the action of a rolling load, the weight, however, being supported by the cables.

Simultaneous with the progress of the Niagara Bridge, another railway suspension bridge was commenced by Mr. Roebling, in the State of Kentucky, across the Kentucky River, on the line of the Southern Railroad leading from Cincinnati to Chattanooga. The gorge of the Kentucky River is both deeper and wider than that of the Niagara, requiring a clear span of no less than 1224 feet. The anchorages and stone towers were rapidly completed, and the necessary plates and saddles hoisted on the towers; most of the cable wire was delivered, as also the material for the superstructure, the girder principle adopted here being essentially different from that carried out in the Niagara Bridge, no floor for vehicles being required in this case, when suddenly the finances of the railway company collapsed, and the bridge, as well as the railway, were abandoned for the time being. At this day the massive towers stand like monuments in the wilderness, places of pilgrimage from the neighboring settlements.

In the fall of 1856, the foundations of the towers of the Ohio Bridge, at Cincinnati, were laid; work was resumed the next year, and then interrupted for want of means.

In the meantime arrangements were made to proceed with the erection of still another suspension bridge at Pittsburgh, to take the place of the old wooden Alleghany bridge, built in 1818, and now no longer safe. The removal of the old structure and construction of the new permanent work, including the building of three new piers

and two anchorages, required three years from 1858 to 1860, inclusive. The total length of this bridge is 1030 feet, divided into two spans of 344 feet each, and two side spans of 171 feet each. The floor has a width of 40 feet, including two sidewalks, 10 feet wide. The framework of the superstructure is composed essentially of iron girders, with a flooring of wood. Ornamental open towers of cast iron support the cables, which are four in number, two of 7 inches diameter, attached to the floor between the sidewalks and carriageway, and two of 4 inches in diameter, attached to the ends of the floor-beams; in addition to the cables, there is an effective system of stays.

This bridge being completed, all enterprise was stopped for a couple of years by the outbreak of the civil war. In 1863, however, operations were resumed on the work at Cincinnati, and the bridge finally finished in 1867.

As regards the future works of Mr. Roebling, it may be mentioned that the reports, plans and estimates of the New York and Brooklyn bridge, across the East River, have been matured during the present year; that with a clear span of 1600 feet, besides the approaches, it will cost about six millions of dollars, and that there is every prospect of enough capital being subscribed to enable operations to be commenced this winter.

From the Proceedings of the Royal Society, No. 92.

(Continued from page 337.)

METHOD OF QUALITATIVE ANALYSIS OF ANIMAL AND VEGETABLE COLORING MATTERS BY THE SPECTRUM MICROSCOPE.

By H. C. Sorby, F. R. S., &c.,

Since the number of divisions depends on the thickness of the interference plate, it became necessary to decide what number should be adopted. At first, I thought that ten would be most suitable; but, on trying, it appeared to me too few for practical work. Twenty is too many, since it then becomes extremely difficult to count them.—Twelve is as many as can be easily counted; it is a number easily remembered, gives sufficient accuracy, and has a variety of other advantages. With twelve divisions the sodium line, D, comes very accurately at $3\frac{1}{2}$; and thus, by adjusting the plate so that a bright sodium line is hid in the centre of the band, when the Nicol's prisms are crossed, it is accurately at $3\frac{1}{2}$, when they are arranged parallel, so as to give a wider field. The general character of the scale will be best understood from the following figure, in which I have numbered the bands, and given below the principal Fraunhofer lines. The centre of the band is black, and they are shaded off gradually at each side, so that the shaded part is about equal to the intermediate bright spaces. Taking, then, the centres of the black bands as 1, 2, 3, &c.,

the centres of the bright spaces are $1\frac{1}{4}$, $2\frac{1}{2}$, $3\frac{1}{2}$, &c., the lower edges of each $\frac{3}{4}$, $1\frac{3}{4}$, &c., and the upper $1\frac{1}{4}$, $2\frac{1}{4}$, &c. We can easily divide these quarters into eighths by the eye; and this is as near as is re-

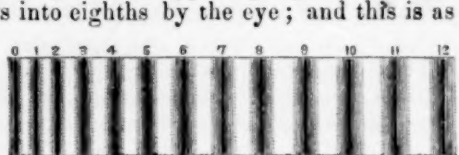


Fig. 1.

quired in the subject before us, and corresponds as nearly as possible to $\frac{1}{100}$th part of the whole spectrum, visible under ordinary circumstances by gaslight and daylight. Absorption bands at the red end are best seen by lamp-light, and those at the blue end by daylight.

On this scale the position of some of the principal lines of the solar spectrum is about as follows:

A..... $\frac{3}{4}$	B.....$1\frac{1}{2}$	C.....$2\frac{3}{8}$	D..... $3\frac{1}{2}$
E.....$5\frac{1}{16}$	*b* ... .$6\frac{3}{16}$	F..... $7\frac{1}{2}$	G.....$10\frac{5}{8}$

At first, I used plates of selenite, which are easily prepared, because they can be split to nearly the requisite thickness with parallel faces; but I found that its depolarizing power varies so much with the temperature, that even the ordinary atmospheric changes alter the position of the bands. Quartz cut parallel to the principal axis of the crystal is so slightly affected in this manner, as not to be open to this objection, but is prepared with far greater difficulty. The sides should be perfectly parallel, and the thickness about ·043 inch, and gradually polished down with rouge until the sodium line is seen in its proper place. This must be done carefully, since a difference of $\frac{1}{10000}$th inch in thickness would make it decidedly incorrect. I have prepared such plates, corresponding to my own, and placed them in the hands of Mr. Browning and of Messrs. Becks, so that any one wishing to adopt a similar scale may be able to do so more accurately.

The two Nicol's prisms and the intervening plate are mounted in a tube and attached to a piece of brass in such a manner, that the centre of the aperture exactly corresponds to the centre of any of the cells used in the experiments, which are all made to correspond in such manner that any of them, or this apparatus, may be placed on the stage and be in the proper place without further adjustment, which, of course, saves much time and trouble.

4. *Symbols used to describe Spectra.*

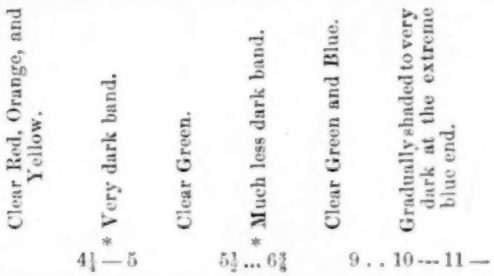
In order to describe spectra in my note-book or in print, I have devised a simple notation, employing types in constant use. Instead of writing an account of this system, I here give a printed illustration, which will show that by this means it is easy to give in a single line all the essential particulars which would otherwise require a long and tedious description, or a number of drawings and woodcuts. With-

out some such method of measuring and recording spectra, it would be almost impossible to carry on extensive inquiries.

The intensity of the absorption is expressed by the following types:

Not at all shaded		Blank space.
Very slightly shaded	. . .	Dots with wide spaces.
Decidedly shaded	. . .	Dots closer together.
More shaded	...	Very close dots.
Strongly shaded, but so that a trace of color is still seen	---	Three hyphens close.
Still darker	—	Single dash.
Nearly black	——	Double dash.

Except when especially requisite, only the symbols . . . --- — are employed for the sake of simplicity, and then as signs of the relative, rather than of the absolute, amount of absorption; and it is assumed that there is a gradual shading off from one tint to the other, unless the contrary is expressed. This is done by means of a small vertical line over the figure (see No. 11), which shows that there is a well-marked division between them. Definite narrow absorption bands are indicated by * printed over their centre. This will be better understood by a description of the spectrum of deodorized hæmatin.


Clear Red, Orange, and Yellow.
Very dark band.
Clear Green.
Much less dark band.
Clear Green and Blue.
Gradually shaded to very dark at the extreme blue end.
4½ — 5
5½ ... 6¾
9 . . 10 --- 11 —

The following examples will show how simple or more complicated spectra may thus readily be printed and compared. I have chosen solutions of similar tint, in order to show that the spectra of those of nearly the same color may be very different, or, if analogous, may differ in details easily expressed by the symbols. The color of each is given after the name. Nos. 1, 8, 9, 10, 11, 12, and 13 can be kept for a long time sealed up in tubes, and the rest are easily prepared. I have in all cases chosen that strength of solution which gives either the most characteristic spectra, or those best suited for comparison with other allied colors.

1.	Cudbear in alum (*Pink*)	3 . . . . . 8 11 . —
2.	Color of Elder berries with citric acid. (*Red Pink*)	4 . - 5½ — 8 - - 9 . . . 11 - —
3.	Brazil wood, with bicarbonate of ammonia. (*Pink*)	* 4½ — 5¾ 8
4.	Logwood, with bicarbonate of ammonia. (*Pink*)	* 3⅝ — 5¼ 7

The next four are spectra of blood, produced by the successive addition of the various reagents, as in detecting fresh stains.

5. Fresh Blood. (*Pale Scarlet*) $3\frac{1}{2}$ — $4\frac{3}{8}$ $4\frac{3}{4}$ — $5\frac{1}{4}$ 7..8--9—

6. Citric Acid then added. (*Pale Brown*) $1\frac{5}{8}$...$2\frac{1}{4}$ 4...8...9---10—

7. Ammonia then added. (*Pale Brown*) $3\frac{5}{8}$...$4\frac{3}{8}$ $4\frac{7}{8}$...$5\frac{5}{8}$ 7..8---10—

8. Deoxidized hæmatin, from blood-stain 2 years old. (*Pink*) $4\frac{1}{4}$ —5 $5\frac{1}{2}$...$6\frac{3}{8}$ 9..10---11—

With these may be compared the two spectra which more nearly resemble those produced by blood than any I have yet seen.

9. Cochineal in alum. (*Pink*) $3\frac{3}{8}$ — $4\frac{1}{2}$...$5\frac{1}{8}$ --- $6\frac{1}{4}$...$7\frac{1}{4}$

10. Alkanet root in alum. (*Pink*) $3\frac{1}{2}$ — $4\frac{3}{8}$ $5\frac{1}{4}$...$5\frac{3}{4}$

The following spectra of compounds derived from chlorophyll are as complicated as any I have met with.

11. Normal chlorophyll in alcohol. (*Deep Green*) $\frac{7}{8}$ — $2\frac{3}{8}$ --- $3\frac{1}{4}$....$4\frac{1}{2}$ $6\frac{3}{4}$..--$7\frac{1}{2}$—

12. Ditto, as decomposed by acids, or as found in some leaves. (*Olive Green*) 1 — $2\frac{1}{8}$ $2\frac{3}{4}$ --- $3\frac{3}{8}$ $4\frac{1}{4}$...$5\frac{1}{4}$ ---$5\frac{3}{4}$...$6\frac{3}{8}$ ---$7\frac{3}{8}$ $8\frac{1}{2}$..--$9\frac{1}{2}$—

13. Ditto, as decomposed by caustic potash, and then by hydrochloric acid. (*Red Green, Neutral Tint*) $\frac{1}{4}$ — $\frac{3}{4}$ $1\frac{1}{8}$ — $1\frac{3}{8}$ $1\frac{7}{8}$ — $2\frac{1}{8}$ $4\frac{1}{2}$ — $5\frac{1}{4}$...9--10—

5. *General Remarks on Absorption, &c.*

It appears to me that in adopting the undulatory theory of light it greatly simplifies the subject before us if we, to some extent, make use of the phraseology of acoustics. And thus, for example, I shall speak of two absorption bands that occur, one nearer the *red*, and the other nearer the *blue* end of the spectrum, as being relatively *lower* and *higher*. In a similar manner, if the addition of some reagent cause the absorption to increase towards the blue, and decrease towards the red end, I shall describe it as *raising* the position of the absorption. We may also make some facts more intelligible by comparing them with the analogous phenomena of sound, and thus, for instance, may suppose that very narrow absorption bands indicate that the ultimate particles of the substance will only take up vibrations of light of nearly one particular velocity, and that broad absorption bands show that the particles have a much less definite rate of movement. Analogy would also lead us to infer that, when two spectra differ very decidedly, they must be due to different substances, or to the same in a different condition; whereas, if two spectra agree, they may be the same substance, or two distinct substances, whose different actions are made equal by particular circumstances. As an illustration, we may refer

to a short string, which may give the same note as a longer whose tension is greater. For this reason we should be careful not to rely too much on one spectrum. If, however, we can produce some great physical change in both substances, and still their spectra remain the same under equal conditions, and if this occur uniformly in several different changes, we may conclude that they are identical. Hence the value of the various reagents named below. Many excellent illustrations of these principles could easily be given.

6. *General Method of Experiments.*

Since the spectrum microscope enables us to use very small quantities, it appeared desirable to adopt such a method of research as would enable us to take full advantage of this circumstance, and to avoid as much as possible previous chemical manipulations. On this account I shall say nothing about modified chemical methods, which may, of course, be also employed when sufficient material is at command. My aim has been to contrive a special system of qualitative analysis of colored substances applicable to minute quantities, and as independent of general chemistry as the blow-pipe method is in the case of minerals. I may here say, that in some very important practical applications to the detection of blood-stains, not above $\frac{1}{100}$th of a grain was at disposal, and yet perfectly satisfactory results were obtained.

I was led to study the coloring matters of flowers, leaves, fruits, woods, and roots, because it appeared a most admirable field of inquiry to teach the general principles of the subject. The colors being so various, and occurring under such complicated conditions, I thought that if methods could be devised to distinguish those that are dissimilar and to prove the identity of those that are alike, even when mixed with colored impurities, such principles could easily be applied to other inquiries. If the question were merely to distinguish or compare absolutely pure coloring matters, there would be little or no difficulty; but it appeared to me that one great value of the method would be to be able to apply it at once to very impure and mixed materials. In such cases mere color is of very secondary importance, since that may be totally changed by a very small amount of impurity.

(To be continued.)

PRESENTATION.—On Thursday evening, the masons employed on the tunnel projected to run under the river at Washington Street, presented a handsome silver trowel to Mr. William Bryson, the engineer in charge of the work. The trowel was suitably inscribed. It was presented at the hands of Mr. P. McMahon Burns, foreman mason, with appropriate remarks. Mr. Bryson made a brief reply. Thirty-one masons participated in the presentation.—*Chicago Times.*

EDUCATIONAL

WHAT IS CIVIL ENGINEERING?

By Prof. S. EDWARD WARREN, Rens. Pol. Institute, Troy, N. Y.

CIVIL ENGINEERING *is a learned profession*, principally physico-mathematical in the substance of the knowledge requisite for the practice of it, and consisting in the *design*, *representation* and *execution* of works, in which the active forces of nature, as steam, etc., or its passive forces, as the weight of retaining walls, are made to minister to the well-being of man.

Let us now partially analyze this definition.

The DESIGNING OF WORKS, and of their major *component structures*, which is the grand function of the engineer, must be governed by the *principles of mechanics*, and this not in a mere general way, but according to definite given conditions to which the works must conform.

Now, *what is mechanics?* This is the point on which, without fault of their own, considering the limited instruction in it, and literature belonging to it, hitherto generally accessible in this country, more or less vague and inadequate views often apparently prevail among projectors of schools of science, as well as, in a far greater degree, among many other people otherwise well informed.

But what is mechanics? Mechanics is a vast and splendid body of science, *the central and dominant member of the entire body of engineering knowledge;* and consisting of the *statement*, *discussion* and *application of the laws of force.* Furthermore, mechanics, thus broadly defined, exists in three successive natural stages, well named Rational Mechanics, Physical Mechanics and Technical Mechanics.

Rational Mechanics is the science of the action and reaction of pure forces, acting directly upon each other, under all possible conditions of intensity, direction and variation, and not acting in and through matter.

Physical Mechanics is the science of the same forces acting in and through matter, and as modified by the properties of matter.

Technical Mechanics, the last and highest stage of the science, is the science of force, considered as acting in and through structures which are assemblages of bodies of definite forms, positions and in-

tended functions. It embraces, therefore, the theory and exact expression of the stability of structures of masonry, wood and metal, as walls, arches, domes and columns, also roofs and bridges of all varieties of design and material, and, in addition, the theory and *exact expression* of the dynamical efficiency of motors of every kind,—locomotive, stationary and marine engines, vertical and horizonal waterwheels, the required or actual strength of boilers of any form or material, the mechanical resources of streams, etc.

All this, only briefly amplified catalogue of particulars, constitutes mechanics, and mechanics is *immediately* requisite in *designing* engineering works. Immediately necessary, I say; hence let us pry under and see what is *fundamentally* necessary.

Mechanics is the science of force, acting in space and time.

Force is a species of quantity.

Mathematics is the science of quantity.

Mechanics, therefore, is a branch of concrete mathematics, and *of such rank* that the problems which it presents are so numerous and varied, and rise to so high a degree of complexity, that their resolution demands all the aid which the resources of pure mathematics can furnish.

Such is mechanics, which, we repeat, is the principal member of the body of engineering science, and such the mathematical proficiency which, by inference, the knowledge of it is shown to require.

Yet this is not all that is requisite for the *designing only* of engineering works. These works are adapted to determinate measurable conditions, and to ascertain these conditions and express them numerically, as given data, is one object of *geodesy*, or the *measurement of terrestrial distances, areas and volumes*, under various conditions of *configuration* and *accessibility*, a science, which, in its higher application to wide areas, requires no mean amount of knowledge of mathematics and practical astronomy.

Such is *engineering design*, which is yet but *one division* of engineering practice.

Such a body of *technical thought* must now have its appropriate *technical language*, wherein to express itself to those workmen who are to give tangible form to it.

Drawing is the language of design, and the drawings of such forms as engineering science is conversant with, demands a large knowledge of the properties of form, with reference to its exact representation, under all possible conditions of variation of figure, position and com-

bination, and exposure to light. And this is the knowledge of descriptive geometry in the broad sense.

Finally, a *design* having been both conceived and wrought up, by mathematical computation of all the quantities entering into it, and then *represented* intelligibly to the workman's eye by a series of exact drawings, its *execution* remains as the crowning member of the engineer's achievement.

Here geodesy re-appears, to do service in staking out the work to be done, and in testing its conformity at its successive stages, to the dimensions prescribed for it; while the engineer crowns the stem and branches of his theoretical knowledge with the flower of executive ability, through his abundant and ready knowledge of precedents, and his fund of wise and ingenious expedients for proceeding in emergencies, and for resolving the problems of purely constructive art, presented in all the varied conditions of foundations, and of the configuration and mode of pre-occupation of adjacent ground.

Lastly, under this head, since the engineer ultimately deals with forces as acting in and through matter and *in the mass*, rather than *in atoms*, experimental physics may properly be ranked as one of the primary subjects of engineering knowledge, embracing, as it does, the general laws and properties of matter in its various forms, solid, liquid and gaseous, and the statement and discussion of the phenomena of light, heat, electricity and magnetism; the principles of which find application in the construction of his geodetical instruments, in the permanency of form of his works, and their preservation from sudden destruction.

Such, now, is engineering in its *principal requirements only.*

But the engineer should, besides all this, know the materials he has to work with, their derivation, properties, and the comparative merits of the same, under the action of ordinary atmospheric influences, and of any ordinary chemical agents to whose action they may be exposed. Hence he should, as subordinate auxiliaries to his principal qualifications, possess a fair knowledge of natural history, chemistry and geology.

Again, the engineer will often have to deal with men, as well as with materials, as, for example, in securing the sympathy, faith, and cooperation of the public in his enterprises, and in securing the adoption and final completion of his plans. Hence he must understand the mental and moral philosophy of human nature and life, engineering law, political economy, so far at least as it includes the bearings of

great works of intercommunication and supply upon national wealth, through their effect upon vigorous production and equable distribution, and æsthetics, so far as to weave into his designs all the beauty that is appropriate to their significance and use, and consistent with their proper cost, remembering that *simplicity* of design is never necessarily *rude*, and may always be beautiful.

Such, at last, is engineering, in somewhat of rounded fullness of feature and outline. Summed up in a condensed definition, it is the constructive science of forms and forces.

Our second question, then, is quickly answered, "What must a finished civil engineer be?" *Primarily*, a good mathematician, well versed in mechanics, familiar with descriptive geometry and projection drawing, an accomplished surveyor and a good physicist. *Secondarily*, a fair chemist, geologist and botanist; wise in dealing with men, and a person of fair taste and good general culture.

This condensed expression of what an engineer must be, made in the light of the previous analysis, shows at once what a "professor of civil engineering" must be. He must be a man who can take a youth, slightly advanced beyond the stage of human raw material, and, by years of training, bring to pass, in the person of that same youth, a a civil engineer conformed to the above description.

What shall we say now to the pretence that *one* man can do all this? And what do people, and institutions, mean by the phrase "professor of civil engineering?"

The first question carries its own answer with it. The second merits a patient answer, followed up by a true conclusion.*

That which is most conspicuous to the eye, prevails in the thoughts of those who are quite ignorant of what *all* of an engineer's qualifications and functions are. Accordingly, the extent and conspicuousness of the engineer's *instrumental operations in the field* may cause *practical geodesy*, or engineering field practice, merely, to be equivalent to "engineering," in some minds, as the substance of a professorship of civil engineering.

If others can see their way a step further, it may be that with them *constructive engineering alone*, treated in books or lectures, *describing the execution*, on the ground, of engineering works previously designed and computed, would be considered the subject matter of a professorship of civil engineering, as with some show of propriety, indeed, it

* See also "Notes on Polytechnic Schools," by the present writer. New York: John Wiley & Son.

might be, considering that the actual execution of engineering works is the final stage of engineering practice.

Here we must observe that, as in medicine, the professor of operative surgery, instructs, not merely by *describing* operations, but by *performing* them before his class, and with their assistance, perhaps; so a professor of *constructive* engineering, strictly so-called, should actually superintend the execution of parts, at least, of engineering works, in the presence of his class. If he only gives lectures, *describing* actual practice, he might be entitled a *professor of descriptive engineering*, unless by a figurative, and in a secondary sense, *that which he describes*, viz: constructive engineering, should thus give the title to his functions.

Again, yet others, rising to a still higher view, might add to this merely descriptive treatment of engineering constructive practice, the last stage of the mathematical science of mechanics, viz: technical mechanics, embracing, as it does, the immediate mathematical theory of actual structures, of definite location, materials, uses and dimensions; but excluding the previous stages of rational and physical mechanics as they have been before defined.

Finally, upon a lower view perhaps of what a civil engineer should be, than has been here presented, or, more probably, by mere force of circumstances, a "professor of civil engineering" may be one who does all that one man of large attainments, fired with zeal in the upbuilding of the profession in his native land, *can* do towards the training of young engineers. This seems to be the meaning attached to this title in several American institutions, and, in truth, we cannot forbear to express both surprise and admiration at what has thus been accomplished by individuals in imparting professional engineering instruction of a high order.

But now, leaving this title, which we nevertheless cannot but clearly regard as a misnomer, hardly less than monstrous, in the light of the foregoing discussion, the phrase "Faculty of Engineering," seems as natural and obviously proper as "Faculty of Law," of "Medicine," or of "Theology," applied to the professors, collectively, in schools of law, medicine and theology. None pretend that *one* man can adequately discharge the entire functions of either of these latter bodies; and nothing but sadly inadequate conceptions of what engineering study and student-practice should be, and, in the most fully developed engineering schools, *actually are*, could any more permit any one, for a moment, to think that one man could be a faculty of engineering.

We now close with the promised conclusion, which shall consist of a statement of the number of members, with their functions, necessary to constitute an adequate faculty of engineering. And to make this statement more definite, we will suppose the case of a *three years' course* of instruction for two hundred students, *high requirements for admission* being supposed to be practicable, through the existence of numerous courses in general (unprofessional) scientific instruction in the preceding class of institutions, viz: the colleges; courses parallel to those in the ancient languages and literature, and directed with reference to the *governing idea* of all merely collegiate instruction, viz: that of *developing mental power*, independently of the immediate application of it to any industrial profession.

FACULTY OF ENGINEERING.

a. Principal or Fundamental Professorships, filled by full resident professors, endowed with ability, and furnished with time to conduct researches, and thence contribute to the advancement of their departments as well as give faithful personal services to students. These should also be aided by a staff of well-qualified assistants, enough to secure the cardinal feature of the *daily test of every student*, and to secure substantially as high quality of instruction to the lower classes as the principal professors could give.

I. *Professor of Mathematics.*

II. *Professor of Rational and Physical Mechanics.*

III. *Professor of Technical Mechanics and Engineering Construction.*

a.—In *Civil Engineering*, embracing the theory, and described and visited execution, of roofs, bridges, walls, arches and domes, and river and harbor improvements.

b.—In *Mechanical Engineering*, embracing likewise the computation and treatment of water-power, and the theory and calculation of the efficiency of steam, water and other prime movers.

continued on p. 132 vol. 55

Franklin Institute.

Proceedings of the Stated Monthly Meeting, October 16th, 1867.

THE meeting was callled to order with the President, Mr. J. V. Merrick, in the chair.

The minutes of the last meeting were read and approved.

The minutes of the Board of Managers were reported by the Actuary, including the following donations to the library: From the Royal Society, the Royal Geographical Society, and the Society of Arts, London; the Association for the Prevention of Steam-Boiler Explosions, Manchester, England; l' Academie des Sciences, and la Société d' Encouragement pour l' Industrie Nationale, Paris, France; das K. K. Geologeschen Reichsanstalt, Vienna, Austria, and the Legislature of Pennsylvania.

The various standing committees reported their minutes, and the Special Committee on Experiments in Steam Expansion reported progress.

The Report of the Resident Secretary on Novelties in Science and the Mechanic Arts was then read. At the conclusion of this, Mr. Robert Briggs drew attention to the fact, that a mixture of glue and glycerine had been very successfully applied in this country as a substitute for the mixture of molasses and glue, previously employed for the making of inking rollers, used in printing presses.

Mr. Hector Orr spoke in commendation of the above improved material.

Mr. Briggs then described a new form of hygrometer, consisting of a wet and a dry bulb thermometer, and a scale, together with a T-shaped index, which, being adjusted in such a manner that its horizontal points coincided with the levels of the mercury in the thermometers, indicated with its vertical branch, on the scale, the amount of moisture present in the air.

Mr. Coleman Sellers called attention to a new sort of artificial stone, which was now being manufactured from sand and lime, and remarks were made on this subject by several members.

Mr. Briggs then made some remarks upon the American patent laws as now existing, and made the following motion, which was duly adopted:

That a committee be appointed to consider the expediency of recommending amendments to the patent laws of the United States. The President then apppointed Messrs. Robt. Briggs, Wm. Sellers and Hector Orr to serve on this committee.

After which the meeting was, on motion, adjourned.

HENRY MORTON, Secretary.

Bibliographical Notice.

Lectures on Animal Chemistry. By William Odling, M.B., F.R.S., London: Longmans, Green & Co.

THE design of this valuable and interesting contribution to chemical literature, is to rob the term "Vital Force" of all that mystery and prestige with which it has been invested. As a first step towards this end, the constitution of the four primary typical compounds is succinctly explained, viz: Hydrochloric Acid, Water, Ammonia and Marsh Gas. Under these four types are arranged a great variety of organic compounds, which are comparable in their composition and properties through the medium of the simple types upon which they are formed. The next step is to show that the more complex bodies are formed by the continued agglomeration of less complex molecules, as kreatine, for example, from urea and sarcosine; sarcosine from glycolic acid and methylamine, and methylamine from wood-spirit and ammonia. The final terms in these series are of a comparatively simple nature, and admit of a ready classification under great groups: "Into bodies of similar constitution and similar properties that are susceptible of mutual metamorphosis, and into groups of bodies of dissimilar constitution and dissimilar properties that are susceptible of mutual metamorphosis," as the fatty alcohol, acid and aldehyd series. By burning off successive atoms of carbon and hydrogen, the chemist can transform the most complex organic substance into more and more simple ones, until at last he arrives at carbonic acid and water; and then, by reversing the process, and removing atom by atom of oxygen from carbonic acid and water, he can build up, stone upon stone, the edifice which he has taken down. The same conservation of force pervades the inorganic and organic. The sun's force, which removes from carbonic acid and water their oxygen and forms plant-tissue, is given out by the oxidation of animal tissue, a unit of heat or mechanical or chemical force being evolved for each unit of solar force absorbed. The supposition of a vital force is not more necessary to account for the formation of organic compounds in the animal body, than it is for their formation outside the body.

A. R. L.

A COMPARISON *of some of the Meteorological Phenomena of* **OCTOBER, 1867,** *with those of* **OCTOBER, 1866,** *and of the same month for* **SEVENTEEN** *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11¼′ W. from Greenwich. By **PROFESSOR J. A. KIRKPATRICK,** of the Central High School.

	October, 1867.	October, 1866.	October, for 17 years.
Thermometer—Highest—degree	80·00°	75·00°	90·00°
" date	19th.	2d & 8th.	4th, '58.
Warmest day—mean	70·00	67·00	78·30
" " date	19th.	2d & 22.	6th, '61.
Lowest—degree	38·00	37·00	28·00
" date	24th & 25th.	5th.	25th, '56.
Coldest day—mean	45·33	45·33	35·80
" " date	24th.	5th.	27th, '59.
Mean daily oscillation	15·39	13·55	15·19
" " range	5·28	5·60	5·42
Means at 7 A. M.	50·71	52·47	51·32
" 2 P. M.	63·55	62·34	62·88
" 9 P. M.	55·79	55.47	55·35
" for the month	56·68	56·76	56·51
Barometer—Highest—inches	30·465	30·326	30·465
" date	24th.	6th.	24th, '67.
Greatest mean daily pressure	30·456	30·302	30·456
" " " date	24th.	5th.	24th, '67.
Lowest—inches	29·556	29·425	29·012
" date	10th.	30th.	26th, '57.
Least mean daily pressure	29·594	29·5·6	29·059
" " " date	11th.	30th.	26th, '57.
Mean daily range	0·175	0·147	0·146
Means at 7 A. M	30·053	29·931	29 916
" 2 P. M	30·065	29·870	29·873
" 9 P. M	30·020	29·911	29·900
" for the month	30·026	29·904	29·896
Force of Vapor—Greatest—inches	0·604	0 611	0 731
" date	5th.	2d.	7th, '61.
Least—inches	·142	·112	·065
" date	24th.	25th.	21st, '59.
Means at 7 A. M	·315	·326	·315
" 2 P. M	·339	·322	·339
" 9 P. M	·350	·345	·326
" for the month	·335	·331	·327
Relative Humidity—Greatest—per cent	100·0	96·0	100·0
" date	29th.	13th.	29th, '67.
Least—per cent	33·0	31·0	23·0
" date	7th & 8th.	5, 15 & 25.	21st, '59.
Means at 7 A. M	81·3	78·7	77·9
" 2 P. M	55·3	54·5	55 9
" 9 P. M	75·9	74·1	73·1
" for the month	70·8	69·0	69·0
Clouds—Number of clear days*	12·	11·	9·9
" cloudy days	19·	20·	21·1
Means of sky covered at 7 A. M	54·8 per ct	61·6 per ct	56·5 per ct
" " " 2 P. M	44·2	56·1	55 1
" " " 9 P. M	40·3	42·6	40 0
" " for the month	46·4	53·4	50·5
Rain—Amount—inches	4·020	3·538	2·992
No. of days on which rain fell	7·	8·	8·7
Prevailing Winds—Times in 1000	N76°37′w·257	N54°41′w·168	N73°29′w·238

* Sky one-third or less covered at the hours of observation.